KING COUNTY CONVEYANCE SYSTEM IMPROVEMENT PROJECT

KING COUNTY WASTEWATER SERVICE TO THE CITY OF CARNATION

MEMORANDUM

SEPTEMBER 2001

HDR

In Association with

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and

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ACKNOWLEDGEMENTS

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INTRODUCTION

This report on wastewater service for the City of Carnation (City) is part of King County's (County) Conveyance System Improvement (CSI) Project. The purpose of the CSI project is to develop and evaluate alternative improvements, and make recommendations for conveyance system projects to provide reliable long-term regional conveyance service to local sewerage agencies.

PURPOSE

Currently, the City's wastewater treatment is provided by local on-site (septic) systems. The City is considering designing, constructing, and operating a local wastewater treatment plant as an alternative to these existing on-site systems. The purpose of this report is to present an alternative financing proposal to the City for the County to provide wastewater treatment services to the City under a contract similar to the County's other component agencies.

As part of this financing proposal, the County requested that the CSI team review and comment to County staff on the treatment sections of the American Engineering Corp.'s November 2000 *City of Carnation Comprehensive Sewer and Facilities Plan* (Carnation Plan). Additionally, the CSI team was asked to evaluate the planning level facilities and costs associated with conveying the City's wastewater flows to the County's system for treatment. This evaluation is then used by the County to develop a proposal for rates and charges so that the City may decide whether or not to select the County as its wastewater treatment service provider. If the County is selected to service provider, the agency would assume the lead responsibility for the design, construction, and operation and maintenance of the either the proposed conveyance line or treatment facility.

This report does not include a review or evaluation of local City collection system alternatives. The collection system is to remain the responsibility of the City under all scenarios detailed below.

BACKGROUND INFORMATION

The initial primary source of background information for the local treatment alternatives in this report is American Engineering Corp.'s November 2000 *City of Carnation Comprehensive Sewer and Facilities Plan* (Carnation Plan) – especially Appendix D, *Proposed Wastewater Treatment Plant Analysis, Design, and Maintenance*, May 31, 2000, H.R. Esvelt Engineering. The primary sources of information regarding the conveyance alternatives are CSI background documents, and King County GIS coverages.

Service Area

The service area for this investigation is the 622 mixed land-use acres within the City of Carnation and an additional 156 adjoining acres outside of the existing city limits but within the County's designated Urban Growth Area (UGA). Figure 9 from the Carnation Plan (attached as Figure 1) shows the various projected service areas.

Population and Flow Forecasts

According to the Carnation Plan, the 1998/99 population of the City of Carnation was 1,725 in 565 residential units. At the start of the Carnation Plan's Phase A in 2003, there will be approximately 2,000 residents in the City. By 2008, the approximate start of Phase B, the City will have a population of 2,616. The ultimate build out of proposed service area (Phase C) will occur in 2020; the City will have grown to 4,974 people.

Table 1 shows the design flows and loadings presented in the Carnation Plan that were used to evaluate the conveyance and wastewater treatment alternatives. Appendix D of the Carnation Plan indicated that the peak hour flow was calculated to be 0.42 mgd for Phase A and 1.25 mgd for Phase C.

Table 1. Proposed Carnation Treatment Plant Design Criteria

Parameter	Phase A	Phase B	Phase C
Flows (mgd)			
Annual average	0.17	0.33	0.50
Max. monthly average	0.22	0.43	0.65
Max. 24-hour	0.30	0.60	0.90
Peak hour	0.42	0.83	1.25
Loadings (lbs/day)			
BOD – annual average	388	776	1,176
BOD – max. monthly average	505	1,010	1,530
Ammonia – max. monthly average	50	100	150
Source: City of Carnation Comprehensive Sewer and Facilities Plan, Appendix D (2000).			

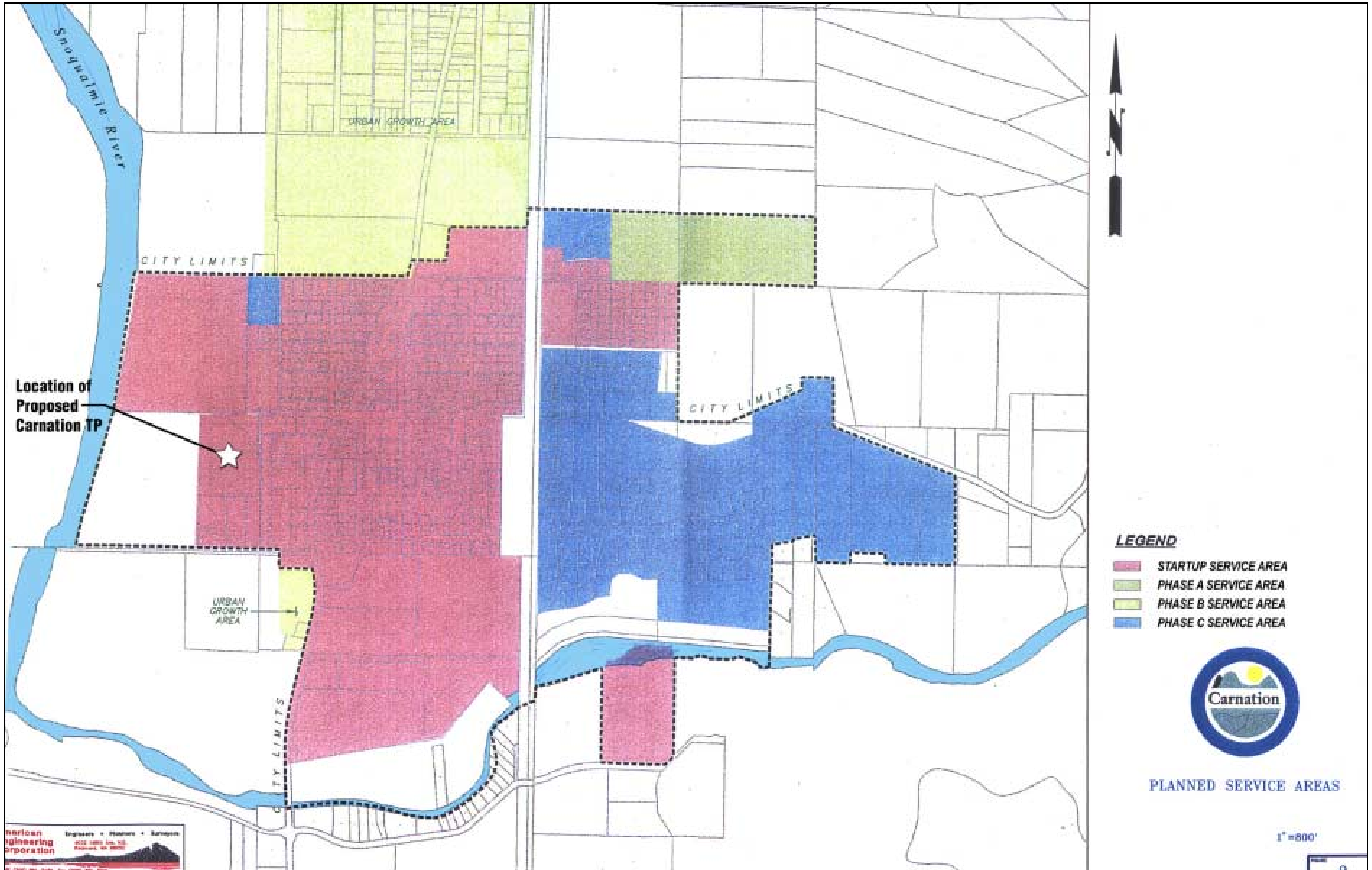


Figure 1. Carnation Service Areas

SERVICE ALTERNATIVES OVERVIEW

Two primary methods of providing these wastewater treatment services were evaluated in this report:

- Conveyance to the County's regional system for treatment at a County regional plant, or
- Treatment at a new local wastewater treatment plant.

The conveyance method requires the construction of new regional pipelines and pump stations to convey the City of Carnation wastewater flows to one of the County's regional wastewater treatment plants. Five alternative alignments were reviewed with total lengths of pipe varying from 11 to 18 miles. Local treatment would involve the construction of a new local wastewater treatment plant located within the City of Carnation. Initial design of the facility relied primarily on the information presented in the Carnation Plan. This design was subsequently revised upon City and County comments to the draft report. The evaluation of these methods is discussed in detail below.

CONVEY FLOW TO REGIONAL SYSTEM

One potential solution to the City's wastewater treatment problem is to convey wastewater to the County's facilities for treatment. This section provides an overview of five alternative conveyance alignments to transfer wastewater flow from the City to the County's sewer system. This section also summarizes conveyance sizing assumptions and methodology, describes the facilities required for each alternative, and provides a construction cost estimate of each alternative.

Conveyance Routing Alternatives

The City of Carnation is located at the confluence of the Tolt and Snoqualmie Rivers, approximately eight miles east of Lake Sammamish. Any flow transfer between the City and the County's wastewater conveyance system would require crossing the topographic divide that separates the Snoqualmie Valley from the Lake Washington/Lake Sammamish watershed. A sharp north-south ridge with rises of more than 500 feet above the Snoqualmie Valley floor separates the two watersheds. GIS and Thomas Guide maps were used to lay out five conveyance alignments that traverse the basin divide and connect with the County's conveyance system (see Figure 2).

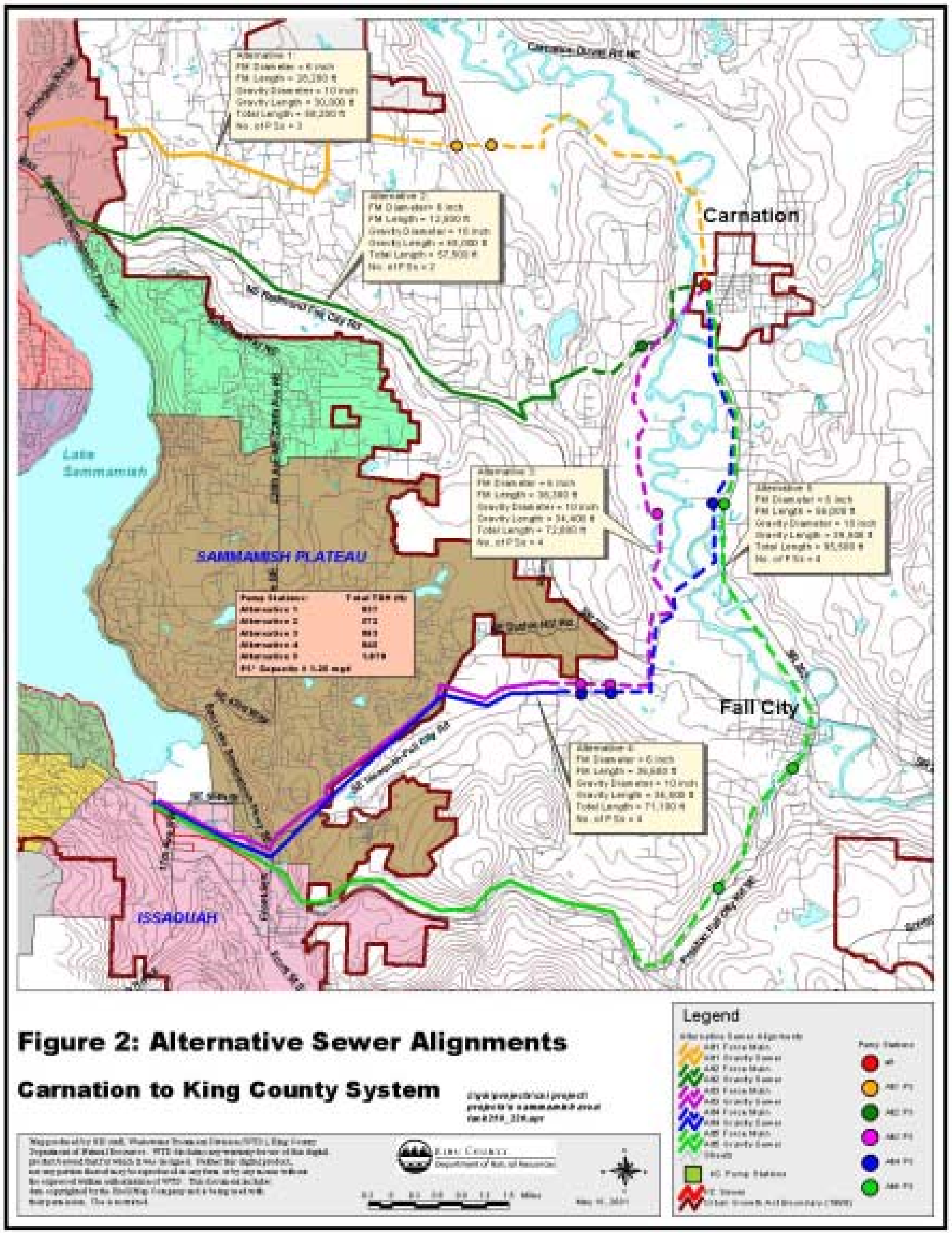


Figure 2. Alternative Sewer Alignments

The alignments were selected using the following guidelines:

- Each alignment originates at the eastern incorporated boundary of the City and connects to the County's sewer system at either the north end or the south end of Lake Sammamish,
- Alignments generally follow existing road rights-of-way with major road routes being preferable, and
- Alignments are routed to avoid temporary elevation gains to minimize total dynamic head (TDH) required for pump stations. (e.g. alignments are routed through valleys rather than traversing hills).

Alternative 1 – Via Redmond Ridge Development
The alignment for Alternative 1 first extends north to avoid crossing the ridge west of the City, and then turns west to cross the north – south ridge south of Redmond Ridge Development in East Redmond. Then the alignment follows existing right-of-ways to the North Lake Sammamish Interceptor. Crossing the ridge by Redmond Ridge Development makes use of road rights-of-way, whereas traversing due west from Carnation would require extensive right-of-way acquisitions. The details of the proposed alignment are:

- Force Main: Alternative 1 originates east of Snoqualmie River and trends north along the river until reaching NE Carnation Farm Road, where it turns to the west, crosses the river, and follows NE Carnation Farm Road and NE 80th Street to W Snoqualmie Valley Road and the base of ridge separating Snoqualmie Valley and Redmond. The alignment traverses the ridge without a road right-of-way to NE 80th Street alignment. The alignment extends to the west along NE 80th Street until 250th Avenue NE, at which point it transitions to gravity sewer.
- Gravity Sewer: From 250th Avenue NE, alignment continues westward along NE 80th Street, 238th Avenue NE, and NE Union Hill Road to 178th Place NE, where it connects to the North Lake Sammamish Interceptor.

Alternative 2 – Via the Tolt Hill Road and Redmond – Fall City Road
The Alternative 2 alignment traverses the north – south ridge, located along the Tolt Hill Road to the west of the City. This alignment skirts hilltops and minimizes temporary elevation gains. The alignment is described as follows:

- Force Main: Alternative 2 originates east of Snoqualmie River and trends southward along the river until reaching Tolt Hill Road, where it turns to the west, crosses Snoqualmie River, and climbs to a plateau near 291st Avenue NE. The alignment skirts the plateau to the north without a road right-of-way and transitions to a gravity sewer west of the plateau.
- Gravity Sewer: The alignment continues to the west from the plateau before intersecting and heading south along 285th Place NE. Alignment continues southward until again intersecting Tolt Hill Road, where it turns westward following

Tolt Hill Road and Redmond – Fall City Road (Highway 202) to about NE 70th Street, where it connects to the NE Sammamish Interceptor.

Alternative 3 – To the South End of Lake Sammamish Via the Snoqualmie River Road
Alternative 3 extends southward to the valley west of Fall City and then runs westward through valley to Issaquah Fall City Road. From here, the alignment then goes to the south end of Lake Sammamish and the Issaquah Interceptor. This alignment would add flow to the South Sammamish Basin rather than the North Lake Sammamish Basin, as in Alternatives 1 and 2. Alternative 3 and the similarly aligned Alternative 4 provide the most direct existing road-based route to the south end of Lake Sammamish. The alignment is described as follows:

- Force Main: Alternative 3 originates east of Snoqualmie River and trends southward along the river until reaching Tolt Hill Road, where it turns to the west and crosses Snoqualmie River to W Snoqualmie River Road. The alignment then follows W Snoqualmie River Road, SE 24th Street, 309th Avenue SE, and 308th Avenue SE to 40th Street, west of Fall City. The alignment continues westward to Sammamish Plateau along 40th Street until 287th Avenue SE, where the alignment transitions to gravity sewer and 40th Street becomes Issaquah Fall City Road.

- Gravity Sewer: The gravity sewer alignment continues westward along Issaquah Fall City Road bordering Sammamish Plateau's eastern border to Front Street N and I-90 to NW Sammamish Road area where it connects to the County's Issaquah Interceptor.

Alternative 4 – To the South End of Lake Sammamish Via the Fall City – Carnation Road
Alternative 4 follows the same alignment as Alternative 3, except that Alternative 4 follows the Fall City – Carnation Road rather than the W Snoqualmie River Road for a part of its length. The Fall City – Carnation Road is a larger roadway that may provide a wider right-of-way but may also have more utilities and higher traffic that would affect construction. The alignment is described as follows:

- Force Main: Alternative 4 originates east of Snoqualmie River and trends southeastward to Fall City – Carnation Road, where it continues to the south until reaching 19th Way. The alignment turns to the west, crosses the river, and continues along 19th Way until reaching W Snoqualmie River Road, where it turns southward to 24th Street northwest of Fall City. At this point, Alternative 4 alignment follows same route as described above in Alternative 3.

- Gravity Sewer: Alternative 4's gravity sewer alignment is the same as the gravity sewer alignment for Alternative 3.

Alternative 5 – Via I-90 Corridor to South End of Lake Sammamish
Alternative 5 alignment extends south to I-90 and continues west to the County's sewer system along the right-of-way.

- Force Main: Alternative 5 originates east of Snoqualmie River and trends southeastward to Fall City – Carnation Road, where it continues south through Fall City, and then along Preston – Fall City Road to Preston and I-90. The alignment transitions to gravity sewer near the Preston – Fall City Road/I-90 exit.

- Gravity Sewer: The alignment follows I-90 west to about NW Sammamish Road where it connects to the County's Issaquah Interceptor.

Conveyance Sizing

As described in the previous Population and Flow Forecasts section, the peak hour flow for Phases A (0.42 mgd) and C (1.25 mgd) were used in the calculations. The facilities included in each conveyance route were sized to convey low flows at a minimum velocity of 2 feet per second (fps) and to convey high flows without causing sanitary sewer overflows or velocities exceeding 8 fps. However, the force main diameter required to maintain minimum velocity for low flow of 0.42 mgd is less than 6 inches. Because the wastewater will likely not be pre-screened prior to pumping, it is not recommended to construct a force main less than 6 inches in diameter. Therefore, if flow is less than 0.60 mgd, some equalization/storage and intermittent pump operation may need to be necessary to ensure that a minimum velocity of 2 fps is maintained.

Pump Stations

Connecting the City's collection system to the County's conveyance system would require a large static lift (more than 480 feet) and a long pipeline (more than 59,000 feet) for all of the alternative alignments. To overcome this static lift and large frictional energy loss, several pump stations would be required along each route. The following assumptions were used to calculate the number of pump stations required:

- Maximum TDH per pump is 150 feet, and

- No more than two pumps in series per pump station (300 feet maximum TDH per pump station).

For simplicity at this planning level phase, all conveyance to the highest point along each conveyance route was assumed to be force main and the remainder of conveyance to the King County sewer system was assumed to be gravity sewer.

For each of the conveyance routes, the first pump station was located in the City and successive pump stations were generally located by moving downstream in increments where the static lift and frictional head losses or combined total dynamic head (TDH) equaled approximately 300 feet between pump stations. GIS analysis of pipe section lengths and 20-foot contours was used to estimate the 300-foot head loss increments. Alternatives 3 and 4 pump station (PS) PS 4 are low head pump stations; for cost estimating purposes, these pump stations were assumed to be half the cost of a 300-foot TDH pump station. The pump station locations reflect hydraulic requirements only. No siting review of the locations has been conducted for this document. Table 2 summarizes the capacity information for the proposed pump stations.

Table 2. Pump Station Information Summary

Proposed Pump Station	PS Elevation[1] (ft)	Static Head[1] (ft)	Friction Head[2] (ft)	TDH (ft)
Alternative 1				
PS 1	40	0	246	246
PS 2	40	260	33	293
PS 3	300	280	18	298
Total:		540	297	837
Alternative 2				
PS 1	40	190	91	281
PS 2	230	250	41	291
Total:		440	132	572
Alternative 3				
PS 1	40	60	197	257
PS 2	100	100	164	264
PS 3	200	260	33	293
PS 4	460	40	9	49
Total:		460	403	863
Alternative 4				
PS 1	40	100	164	264
PS 2	60	80	180	260
PS 3	220	260	33	293
PS 4	480	20	8	28
Total:		460	385	845

(continued)

Table 2. Pump Station Information Summary (continued)

Proposed Pump Station	PS Elevation[1] (ft)	Static Head[1] (ft)	Friction Head[2] (ft)	TDH (ft)
Alternative 5				
PS 1	40	100	164	264
PS 2	60	40	213	253
PS 3	180	160	115	275
PS 4	340	180	98	278
Total:		480	590	1,070

[1] Source: KCWTD 20-foot topographic coverage

[2] Darcy-Weisbach equation used to calculate frictional losses. A frictional coefficient "f" value of 0.02 was used.

Pipelines

As mentioned above, pipeline sizes were selected so that velocities would be greater than 2 fps to prevent solids deposition and less than 8 fps for all flow conditions. A low flow value of 0.42 mgd and a peak flow value of 1.25 mgd were used in the calculations. For the gravity sewer, Manning's equation was used to compute "normal" (i.e. non-accelerating) flow depths and velocities over the range of flow conditions to ensure that low flow velocities were adequate and that during peak flow, pipe capacity was sufficient and velocities were less than 8 fps. The slope was calculated as the average slope from the upstream end to downstream end of gravity sewer, and a Manning's roughness coefficient of 0.015 was used. Using the projected peak and low flows, a 10-inch diameter gravity sewer and a 6-inch diameter force main diameter were calculated for all routes. Table 3 presents a summary of each conveyance component.

It was assumed that the pipelines would be installed using conventional open-cut and cover construction. Alternative pipeline construction methods such as horizontal directional drilling (HDD) could potentially reduce the invert elevation changes along the pipeline alignments and eliminate one or more pump stations. HDD was not investigated because no local information on HDD installation of long, small diameter pipelines was available. If it is determined that transfer of the City's wastewater flow to the County's system is preferable to local treatment and discharge, the feasibility of alternative pipeline construction methods, such as HDD, should be investigated.

Table 3. Conveyance Pipeline Summary

Alignment Alternative	Force main		Gravity Sewer				Total Length (ft)
	Length (ft)	Dia. (in)	Length (ft)	Dia. (in)	Slope (ft/ft)	d/D	
Alternative 1	28,200	6	30,000	10	0.019	0.63	58,200
Alternative 2	12,500	6	45,000	10	0.012	0.75	57,500
Alternative 3	38,300	6	34,500	10	0.014	0.73	72,800
Alternative 4	36,600	6	34,500	10	0.014	0.73	71,100
Alternative 5	56,000	6	39,500	10	0.013	0.74	95,500
Note: d/D was calculated directly using Manning's equation. d/D values given are for a flow of 1.25 mgd.							

Environmental and Permitting

The potential environmental impacts and permitting requirements for the wastewater conveyance alternatives are discussed in the report section Environmental Conditions.

Regional System Impacts

Regional impacts associated with the City's collection system construction would be realized if the City's flows are transferred to the County's system. The conveyance transfer routes would add wastewater to either the Hollywood PS or Metro East Side Service Basins for treatment at the County's existing West Point and South treatment plants or at the future Brightwater TP. While the amount of flow generated in the City would be small relative to the total flow in the service basins, the impact of adding flow to existing or planned facilities must be considered.

City flows can be feasibly directed to the King County conveyance system if it is decided that transferring the City's wastewater to the County is beneficial. The conveyance alternatives developed by the CSI project team for the South Sammamish Basin could accept additional flow from the City, and the CSI project team must evaluate whether any of the planned facilities in the South Sammamish *Working Alternative* will require additional capacity. Similarly, CSI planning in the North Sammamish Basin must consider the possible transfer of City flows when formulating and evaluating wastewater conveyance alternatives.

Operation and Maintenance

The long travel time between the City's and County's systems would create significant odor and corrosion issues. Odor and corrosion control measures would be required at each pump station, and regular inspection and cleaning would be required to reduce sulfide buildup. A flushing system would need to be designed as part of the gravity sewer.

The proximity of the odor release points (pump stations, manholes, etc.) to residential and other sensitive receptor areas would dictate the level of odor control required. Generally for this type of project, the following odor control measures are considered viable:

- On-site foul air treatment
    - Activated carbon adsorption
    - Chemical scrubbing (absorption)
    - Biofiltration
- Atmospheric venting at strategic locations
- Liquid stream chemical addition

All odor control options listed above except for atmospheric venting at strategic locations would require some level of operation and maintenance. Given the high probability of significant odor problems, an odor control facility requiring operation and maintenance would most likely be necessary to achieve the required level of odor control.

Capital Costs

Preliminary capital cost estimates were prepared for the pump stations, force mains, and gravity sewers. In addition, cost estimates for odor control, special crossings (i.e., micro tunneling under streams and roads), and right-of-way acquisition were included. Because of the long wastewater travel time and corresponding expected high levels of hydrogen sulfide in wastewater stream, it is assumed that HDPE pipe material will be used for both the gravity sewer and force main. Thus, cathodic protection for pipeline corrosion control is not included in the cost estimate. Table 4 presents a cost summary for the conveyance components of the City of Carnation wastewater transfer. The construction cost estimates were obtained from the King County CSI cost model (Tabula version 0.6.1) using the assumptions listed in Table 4.

Table 4. Proposed Conveyance System Capital Costs Summary

Parameter	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Forcemains[1]	$4,399,000	$1,950,000	$5,975,000	$5,710,000	$8,736,000
Gravity sewers[1]	$5,250,000	$7,875,000	$6,038,000	$6,038,000	$6,913,000
Pump stations[2]	$3,000,000	$2,000,000	$3,500,000	$3,500,000	$4,000,000
Odor control[3]	$450,000	$300,000	$525,000	$525,000	$600,000
Stream crossings[4]	$555,000	$278,000	$278,000	$555,000	$833,000
Road crossings[4]	$222,000	$333,000	$222,000	$222,000	$333,000
Project construction cost	**$13,876,000**	**$12,736,000**	**$16,538,000**	**$16,550,000**	**$21,415,000**

[1] Assumed native backfill, six feet cover, standard trench safety, minimal dewatering, average utility interference, light traffic, and trench width restoration. Tabula calculated a unit cost of $156/ft for the 6-inch force main and $175/ft for the 10-inch gravity sewer (including manholes every 500 feet).

[2] Assumed 20 foot pump station depth, 1.25 mgd capacity, and 300-TDH. Tabula calculated PS construction cost to be $1M/PS. Construction costs for PS 4 for Alternatives 3 and 4 were considered half of 300-TDH pump station cost ($500,000 each).

[3] Assumed $150,000 per pump station for an on-site foul air treatment odor control facility.

[4] Assumed 50' stream corridor + 100' setback from stream bank, stream micro tunnel length is 250'. Assumed all road rights-of-ways extend 100'. Shaft depths of 20 feet and residential easement required for intermediate launch shafts. Tabula calculated $1,110/ft for both road and stream micro tunnel. Assumed one stream crossing for Alternatives 2 and 3, two for Alternatives 1 and 4, and three for Alternative 5. Assumed two road crossings for Alternatives 1, 3 and 4 and three for Alternatives 2 and 5.

The project construction costs were then calculated using King County's budgeting model spreadsheet to determine the total project cost for the county. Results of the model are listed in Table 5. The model allowed the engineering and construction management tasks to be handled either by consultants or in-house by the county. These options did not affect the project's total cost, only the allocation of the cost. Cost estimates shown are for the year 2001.

Table 5. Conveyance System Project Costs for King County

Project Cost Item	Alternative				
	1	**2**	**3**	**4**	**5**
Construction cost	$13,876,000	$12,736,000	$16,538,000	$16,550,000	$21,415,000
Tax and construction contingency	$2,498,000	$2,292,000	$2,977,000	$2,979,000	$3,855,000
Engineering	$2,498,000	$2,292,000	$2,977,000	$2,979,000	$3,855,000
Construction management	$1,665,000	$1,528,000	$1,985,000	$1,986,000	$2,570,000
CIP labor	$1,596,000	$1,465,000	$1,902,000	$1,903,000	$2,463,000
Other labor	$937,000	$860,000	$1,116,000	$1,117,000	$1,446,000
Other fixed costs	$139,000	$127,000	$165,000	$166,000	$214,000
Land ROW[1]	$2,002,000	$1,978,000	$2,504,000	$2,446,000	$3,285,000
Project contingency	$2,276,000	$2,089,000	$2,712,000	$2,714,000	$3,512,000
Total project cost	**$27,487,000**	**$25,367,000**	**$32,876,000**	**$32,840,000**	**$42,615,000**

[1] ROW costs were calculated using Tabula and not from the KC budget model. Assumed residential right-of-way and easement acquisition would be required for 5% of alignment length. Tabula calculated a unit cost for both residential right-of-way and residential easement acquisition as $688/ft.

Implementation Schedule

The Carnation Plan indicates that Phase A of the wastewater collection system plan needs to be constructed by the fall of 2003. As of this writing (June 2001), this schedule is likely not attainable. Assuming that a decision can be made to proceed and funding can be quickly arranged the following schedule is more probable:

- Apply for grants and funds — Fall 2001
- Structure funding program — Winter 2001
- Begin conveyance supporting environmental studies — Winter 2001
- Select conveyance alternative and begin design — Winter - Spring 2002
- Adopt design of conveyance project and apply for permits — Summer 2002

- Complete design and secure agency approvals and permits — Spring 2003
- Advertise for bids for conveyance project — Summer 2003
- Award conveyance construction contract — Fall 2003
- Begin construction of conveyance project — Winter 2003
- Startup conveyance project — Summer 2005

LOCAL WASTEWATER TREATMENT

The second alternative, local wastewater treatment, would require the construction and operation of a wastewater treatment plant in the City of Carnation, with an outfall to the Snoqualmie River. As previously mentioned, the design, construction, and operation and maintenance of the facility would become the responsibility of the County.

This section reviews the layout, costs, permitting requirements, and implementation schedule of the proposed treatment plant. A summary of the design criteria in the *City of Carnation Comprehensive Sewer and Facilities Plan* will be presented followed by a recommended design summary that meets County requirements.

Design Criteria for Proposed Treatment Plant

It was envisioned in the Carnation Plan that the facility would be constructed in three phases (A, B, and C) to meet projected population increases in the service area. Phase A would meet wastewater treatment demands from now to approximately 2008, when Phase B construction would be completed. However, because of the length of time that will be required to obtain the permits, especially the Corps of Engineers permit for the outfall, it may be more likely that initial construction would be through Phase B. Phase C would be the ultimate build out of the proposed service area. The anticipated design flows and solids loading for these phases were previously listed in Table 1.

The expected effluent water quality requirements for the proposed treatment plant are very stringent since the outfall would be into the Snoqualmie River. The requirements are listed in Table 6. The proposed facility was designed to meet Phase B requirements as the Carnation Plan did not list effluent water quality requirements for Phase A.

Table 6. Effluent Water Quality Requirements for Proposed Carnation TP

Parameter	Phase B	Phase C
$CBOD_5$ (mg/L)	5.5	3.6
$CBOD_5$ (lbs/day)	25.0	25.0
Ammonia-N (mg/L)	1.7	1.1
Ammonia-N (lbs/day)	8.4	8.4
Soluble reactive phosphorus (mg/L)	0.83	0.55
Soluble reactive phosphorus (lbs/day)	3	3
Notes: Washington is currently studying if water quality limits for soluble reactive phosphorus should be implemented. The values listed are planning level estimates. Source: City of Carnation Comprehensive Sewer and Facilities Plan, Appendix D (2000).		

Summary of Carnation Facilities Plan Treatment Plant Design

The proposed Carnation WWTP as outlined in the *City of Carnation Comprehensive Sewer and Facilities Plan* (Carnation Plan), would be sited on 10.4 acres of city-owned property between the main residential/commercial core of the city to the east and the Snoqualmie River to the west. The western two-thirds of the property lie within the 100-year floodplain of the Snoqualmie River. The site plan is shown in Carnation Plan's Appendix D, Figure 1, which has been attached to this report as Figure 3.

The proposed treatment plant in the Carnation Plan was designed to accommodate Phase A maximum monthly flows and loadings. According to the plan, the total design life of the proposed treatment plant was more than 20 years. The reliability class of the proposed treatment plant, as rated by the Washington State Department of Ecology (Ecology) was not included in the report.

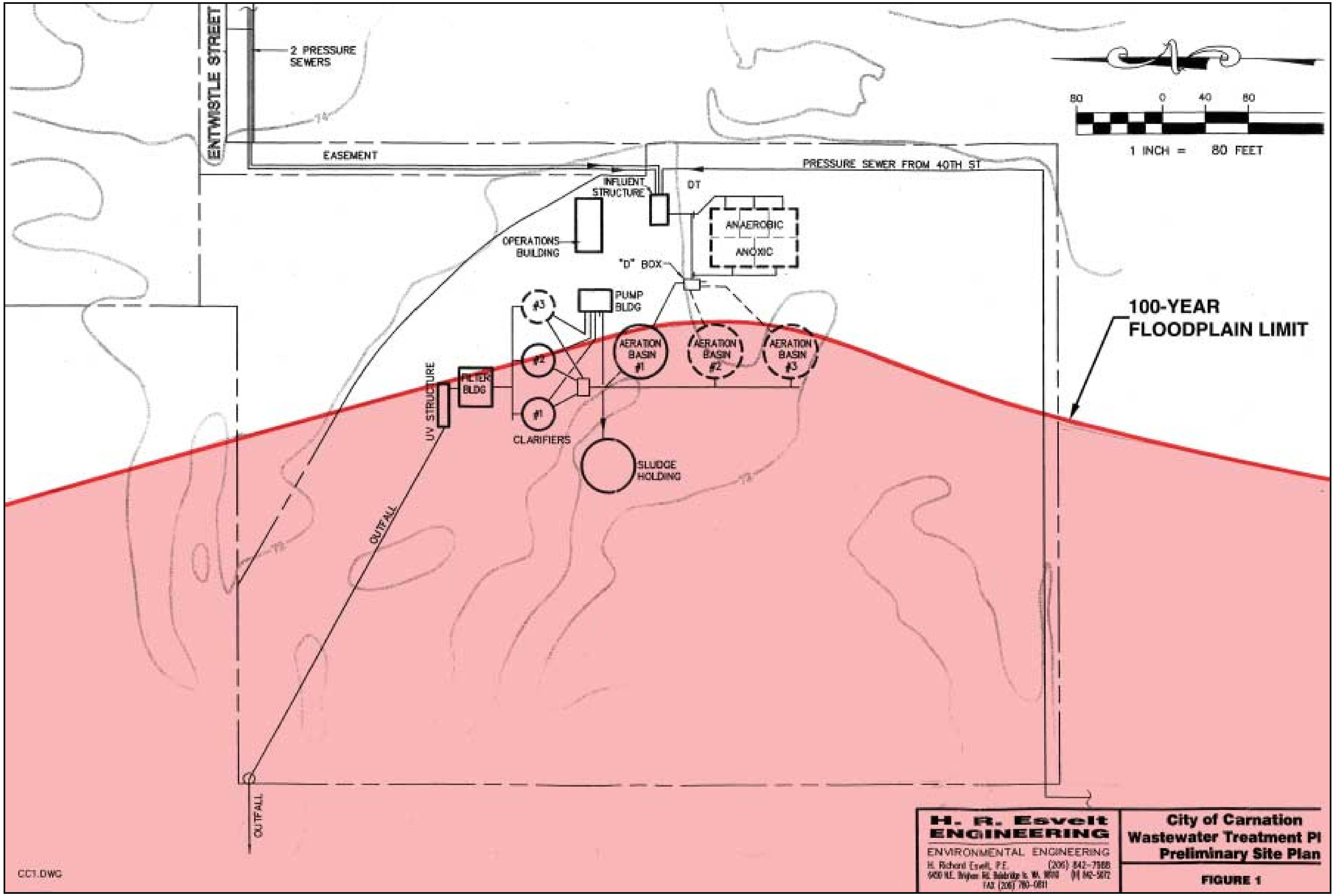


Figure 3. Proposed Carnation TP Site Plan

Headworks

The treatment plant would have one set of in-channel fine screens in the influent structure to remove inorganic particulates from the influent wastewater stream, with a set of manually cleaned bar screen as the backup. Flow measurements would be taken using an ultrasonic depth measurement instrument at a Parshall flume upstream of the screens. The Carnation Plan stated that dedicated grit removal equipment would not be required since the recommended pressurized collection system would not draw in grit and sand, the fine screens would remove larger particles, and that the aeration basin would remove the smaller particles. To remove the accumulated grit in the aeration basin, the basin would be drained and the grit would be shoveled out by hand.

Extended Aeration Basin and Clarifiers

Wastewater treatment for Phase A would consist of using one extended aeration basin with two secondary clarifiers to remove BOD and ammonia. The aeration basin would be sized to provide 31 and 17 hours of detention time for Phase A annual average and maximum 24-hour flows, respectively. The plan did not address the issue of what occurs when the lone basin needs to be drained for grit removal.

For Phase A, two clarifiers would be constructed, one actively used and one to serve as a backup. The redundant clarifier would also be used to thicken waste sludge prior to discharge to a sludge holding tank. It was not described in the report where the thickening sludge would go if the backup clarifier needed to come on-line. The proposed plant's design data for each phase of development were listed in Table 6.2 of the Carnation Plan and summarized in Table 7 below.

One additional aeration basin and clarifier would be constructed to accommodate Phase B flows. Additional anaerobic and anoxic basins may be added in front of the aeration basin to comply with future biological phosphorus removal requirements. The plan showed that the basins would not be installed until Phase B. The basins would recirculate wastewater from the aeration basin to an undefined point upstream of the aeration basin. There was no further discussion on the design and sizing of these basins.

Effluent Filtration and Disinfection

Additional BOD removal would be accomplished with a single-media filter. A chemical or polymer feed system and flocculation chamber would be constructed prior to the filter. The Carnation Plan recommended using either a sand filter with a traveling bridge manufactured by the Schreiber Corporation or Aqua's full size disk filter. Design data for the filtration system alternatives are listed in Table 8. The wastewater would then be disinfected with ultraviolet light prior to being discharged in the Snoqualmie River. The disinfection system for Phase A would consist of a single bank of 24 UV lamps. A second bank of 24 lamps would be online for Phase B. No discussions on the evaluation of the UV system and alternative disinfection processes were included in the Carnation Plan and the plan did not specify the UV lamp type, system configuration, or the UV dosage. There was also no discussion on what disinfection procedures would be implemented if a bank of lamps failed.

Table 7. Proposed Carnation Treatment Plant Design Summary

Treatment Plant Component	Value		
	Phase A	Phase B	Phase C
Influent Structure			
In-channel fine screens	1	1	1
Bypass manual bar screens	1	1	1
Biological Phosphorus Removal			
Anaerobic basins	0	2	3
Volume per basin (gallons)	N/A	56,100	56,100
Anoxic basins	0	2	2
Volume per basin (gallons)	N/A	90,000	90,000
BOD and Ammonia Removal			
Extended aeration activated sludge basins	1	2	3
Volume per basin (gallons)	216,500	216,500	216,500
Secondary clarifiers	2	3	4
Sidewall depth (feet)	12	12	12
Total clarifier surface area (square feet)	1,232	1,847	2,463
Wastewater Disinfection			
Banks of UV lamps in series	1	2	3
Number of lamps per bank	24	24	24
Sludge Handling			
Sludge holding tanks	1	1	1
Volume per tank (gallons)	50,000	50,000	50,000
Number of belt filter presses	0	1	1
Source: City of Carnation Comprehensive Sewer and Facilities Plan, Appendix D (2000).			

Table 8. Proposed Carnation Treatment Plant Effluent Filtration Design Data

Treatment Plant Component	Value		
	Phase A	Phase B	Phase C
Polymer feed system with floc chamber	1	1	1
Alternative 1			
Aqua full size disk filter	1	1	1
Number of disks	2	2	4
Alternative 2			
Schreiber filter units with traveling bridge	1	2	2
Surface area of filter units (square feet)	16	16	16
Source: City of Carnation Comprehensive Sewer and Facilities Plan, Appendix D (2000).			

Biosolids Handling and Disposal

As previously mentioned for Phase A, the backup clarifier would be used to thicken the waste sludge prior to discharging it to the sludge holding tank. The sludge would then be hauled to a licensed biosolids disposal facility, such as the South TP. For Phases B and C, belt filter presses could be used to dewater the sludge to produce Class B biosolids. The biosolids would be sent to Eastern Washington for use as agricultural fertilizer. Alternatively, a composting facility could be constructed to stabilize the sludge and dispose of the material locally.

Water Reuse

The Carnation Plan's discussion was limited to a brief outline describing the additional processes and equipment required for the proposed plant to produced Class A reclaimed water. The report did not include any sizing data for the equipment and did not include the additional pumping station, storage tanks, or disinfection structure in the site plan.

100-Year Floodplain

The preliminary site plan for the proposed treatment plant in the Carnation Plan has the aeration basins, clarifiers, sand filtration building, UV structure, and the sludge holding tanks in the 100-year flood plain. The document did not contain information regarding the additional cost of measures to construct facilities within the flood plain.

Other Issues

Items not included in the report were detailed evaluations of the alternative plant designs mentioned in the report and their costs, the design data and cost for odor control facilities, the environmental impact of siting the facility in a 100-year flood plain and the outfall in a waterbody with salmonids, and the public response and acceptance on any section of the proposed treatment plant. The construction/implementation timeline and the project feasibility report were also missing from the Carnation Plan. A detailed review regarding information missing from the design listed in the Carnation Plan is included in Appendix B.

Recommended Treatment Plant Design Summary

Since the proposed treatment plant would be discharging to the Snoqualmie River, a primary contact recreation water, this will most likely require that the entire facility be a Reliability Class I operation, pursuant to the Washington State Department of Ecology (Ecology)'s *Criteria for Sewage Works Design*. In addition to the requirements for Ecology, the County would also require backups and redundancies throughout the entire plant such that a failure of any single component would not cause a NPDES discharge permit violation. Starting with the original facility layout, several aspects of the Carnation Plan design were modified to comply with the County and Ecology requirements. The flow schematic for the revised design is shown in Figure 4. Discussion regarding each component of the proposed Carnation Treatment Plant is included below. Each biological component was sized to meet the Carnation Plan's anticipated maximum month daily flows to the treatment plant. All other processes were sized to meet maximum 24-hour flows.

Due to the discrepancies in the implementation schedule in Carnation Plan, it is anticipated that construction of the proposed treatment plant will skip Phase A and will be built to meet Phase B flows and loadings. These discrepancies are detailed in the implementation section.

Headworks
Rather than sizing the one in-channel fine screen and one manually cleaned bar screen in the influent structure for Phase B maximum monthly mean flows, the revised design would be sized for 0.65 mgd, the Phase C maximum monthly mean flows. The reason for the modified design is because the pricing differences for screens sized for 0.43 mgd, Phase A maximum monthly mean flows, and for 0.65 mgd are minor and the need to replace the screens at a future date would be eliminated.

Since the Carnation Plan design did not adequately address the issue of grit removal, a vortex-type grit chamber would be installed after the screens in the influent structure. For Reliability Class I, only one grit chamber would be required for the facility for all phases of plant expansion. The grit chamber would also be sized to accommodate 0.65 mgd for the same reasons listed for the screens. A building would enclose both the screens and grit classifying equipment and would have odor control equipment.

Anaerobic/Anoxic Basins
Biological phosphorus removal would most likely required by the County, if it is the lead agency, to comply with discharge requirements set by Ecology, the National Marine Fisheries Service, and the US Army Corp of Engineers (USACE). If required, calculations indicate that phosphorus removal for Phase B flows would require two sets of anaerobic and anoxic basins with minimum volumes of 6,700 gallons each. The engineering calculations are shown in Appendix B. Designing the basins to be 8 feet wide by 15 feet long and 8 feet deep will give each basin a volume of 7,180 gallons. An additional set of basins would be built for Phase C.

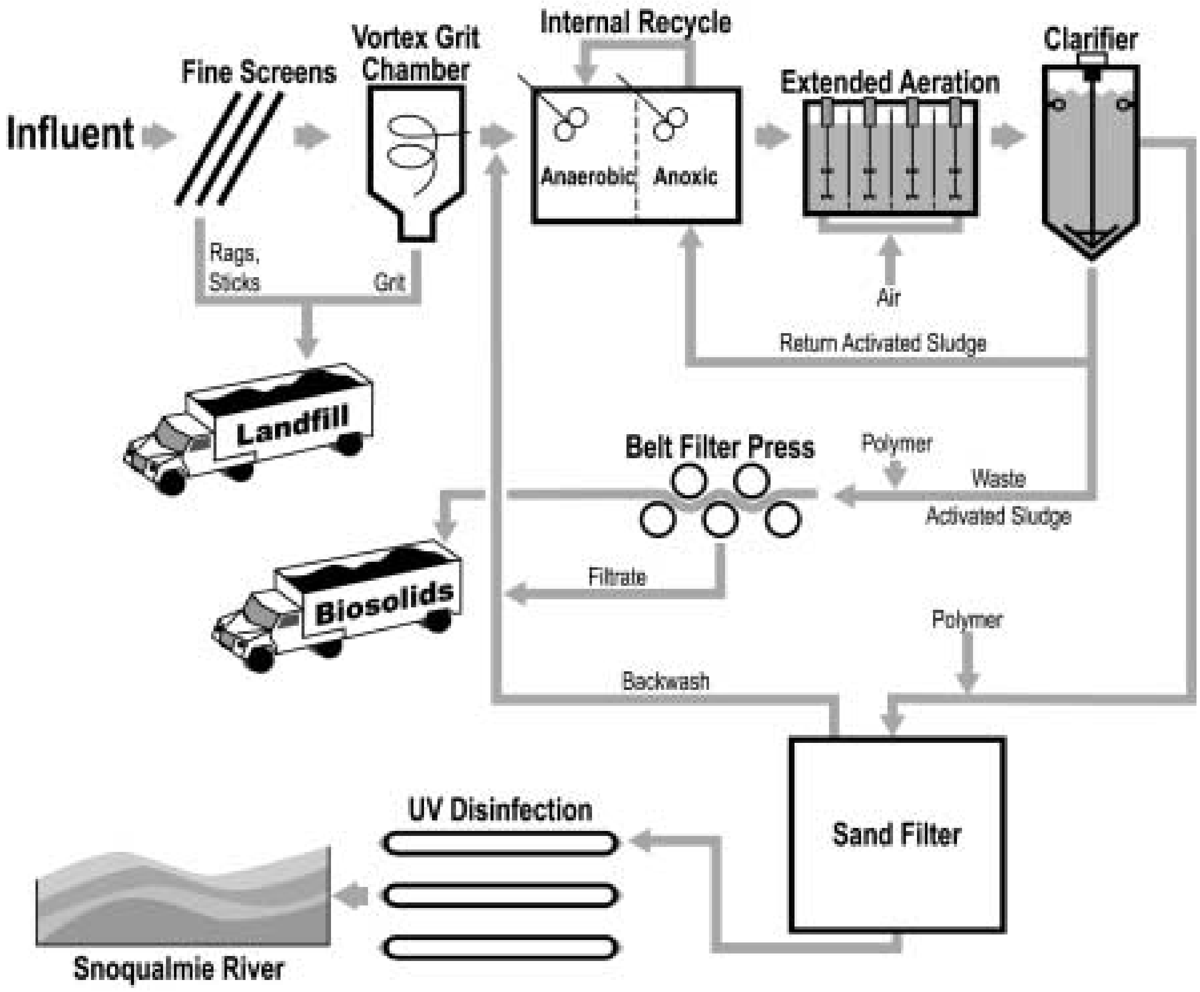


Figure 4. Process Schematic for Carnation Treatment Plant.

Each of the basins would have a mixer and would need to be covered for odor control and to limit oxygen diffusion into the wastewater. Fifty percent of the flow from the anaerobic basin entering the anoxic basin would be recycled back to the anaerobic basins. Also, the return activated sludge from the clarifier would be sent to the anoxic basin. This type of design will protect the anaerobic basin from nitrate recycling if denitrification ever fails.

Extended Aeration Basin and Clarifiers

For Phase B, two extended aeration basins with two cells each would be constructed. Each basin would be 30 feet wide by 48 feet long and 16 feet deep for a basin volume of 0.17 MG each. Detention times in the basins would be essentially the same as those listed in the Carnation Plan. A minimum of 225 scfm of air would be required for complete nitrification in each basin while maintaining 2 mg/L dissolved oxygen in the aeration effluent. To accommodate maximum 24-hour flows, a 30% increase in the air supply above the monthly mean flow would necessitate an air blower capable of delivering 300 scfm to each basin. One redundant blower system would be installed for backup. The basins will be covered to assist in odor control. An additional basin of equal size and the same equipment of the other two will be constructed for Phase C.

Two secondary clarifiers would be required for Phase B and three for Phase C. The size of the clarifiers would be increased from those design data outlined in the Carnation Plan. Table 9 lists the revised clarifier design parameters. The size increase was to comply with Reliability Class I requirements that the clarifiers can handle of 75% of the design flow with one of the clarifiers off-line. Overflow flow rates and detention times for the new design are listed in Table 10. Sixty percent of the influent flow through the clarifier would be returned ahead of the extended aeration basins if biological phosphorus removal is not required. The sludge return would be moved to the anoxic basins once the anaerobic and anoxic basins are constructed. Wasting of the activated sludge is done to sludge holding tank to maintain sludge age and the mixed liquor suspended solids concentration in the processes.

Table 9. Revised Clarifier Design Parameters

Clarifier Parameter	Value
Number required for Phase B	2
Number required for Phase C	3
Diameter (feet)	30
Sidewall depth (feet)	16
Surface area per clarifier (ft^2)	707
Volume per clarifier (ft^3)	8,482

Table 10. Overflow Rates and Detention Times for Secondary Clarifiers

Design Flow Event	Flow per Basin (mgd)	Calculated Overflow Rate (gal/ft^2-d)	Typical Overflow Rate (gal/ft^2-d)	Detention Time (hours)
Phase B and C annual mean	0.17	241	200 – 400[(1)]	9.0
Phase B and C maximum 24-hour	0.30	424	600 – 800[(1)], 500[(2)]	5.1
Phase B and C maximum hour	0.42	594	not available	3.6
Phase B with one basin off line for 75% of maximum 24-hour	0.45	637	600 – 800[(1)], 500[(2)]	3.4
Phase C with one basin off line for 75% of maximum 24-hour	0.34	481	600 – 800[(1)], 500[(2)]	4.5

Notes:
[(1)]: rates from Wastewater Engineering - 3rd. ed. (Metcalf & Eddy 1991).
[(2)]: rates from Washington Dept. of Ecology Criteria for Sewage Works Design (WSDOE 1997)

Effluent Filtration

The revised treatment process would not use the Schreiber sand filter or the Aqua disk filter. Instead, a conventional sand filter comprising of three cells, with 165 square feet surface area total, would be used. The filter would be adequate for all phases of treatment plant development. While the Schreiber filter may be able to produce effluent suitable for river discharge, the system is currently not a proven water reuse technology. The disk filter was not chosen due to its greater mechanical complexity through it has been approved for water reuse. To assist in the solids capture, a polymer feed system would be installed prior to the sand filters.

The use of UV light to disinfect the filtered effluent was not changed. Since the Carnation Plan did not specify the lamps' type, number, and configuration, it was assumed that the proposed Carnation TP would have horizontal low pressure lamps. Due to the nature of the outfall location, the process would be sized to the maximum 24-hour flows to ensure continuous disinfection year round.

Using a rule of thumb value of 40 lamps per 10 mgd for this type of lamps, the system would require 2.4 lamps for Phase B. Including a 50% system redundancy would bring the total number of lamps to four, consisting of two banks each with two lamps. A third bank of lamps would be added for Phase C. The lamps will installed in series in a single concrete channel.

Outfall

For the purpose of cost comparisons, the outfall into the Snoqualmie River was assumed to be a 1,320 feet long prestressed concrete pipeline 18 inches in diameter. As per the Carnation Plan, the outfall would be open-ended, with no diffuser ports, and sited such that it remains submerged at low-flow river conditions.

Biosolids Handling and Disposal

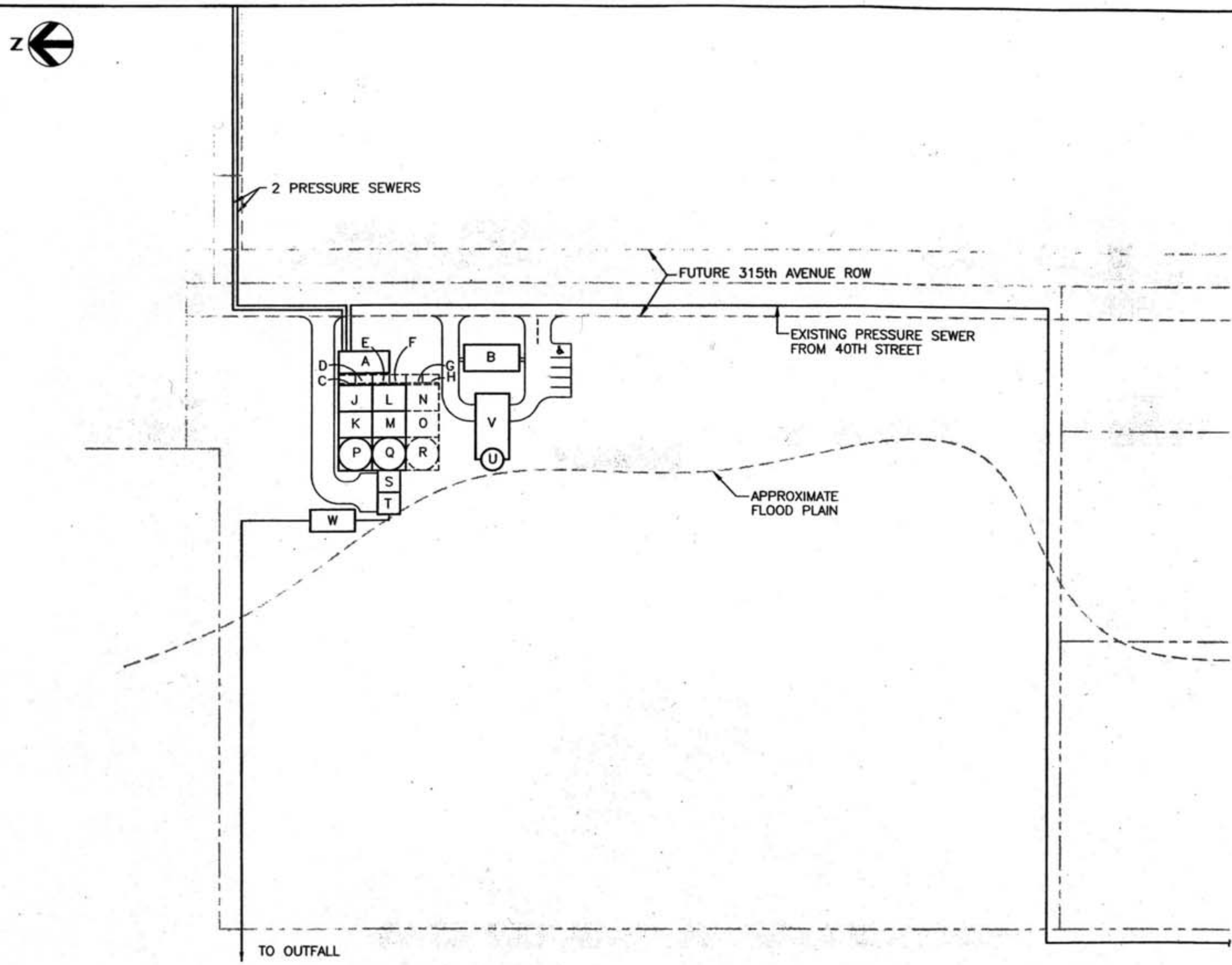
For Phase B, the proposed treatment plant would produce an estimated 727 lbs TSS/day, approximately 5,700 gallons of unthickened 1.5 percent (typical) solids waste activated sludge (WAS) per day. Initially, tanker trucks can haul the unthickened WAS to the County's South Treatment Plant in Renton for solids processing. At the estimated WAS production rate, a 6,000 gallon tanker truck would leave the facility once a day.

A belt filter press could be installed to handle the increased solids production later in Phase B or for Phase C. Assuming that the press produces a cake with 15% solids content, 570 gallons (2.8 cubic yards) of sludge cake would produced per day for Phase B. A 20 cubic yard truck would leave every week to either to the County's existing biosolids disposal sites in Eastern Washington or in the Cascade Mountains.

The dewatered sludge could also be shipped to GroCo Inc. of Kent, the company contracted by the County to compost biosolids for commercial resale. The supply of additional biosolids to GroCo should not affect operations since the volume is small compared to the volume received daily from the West Point and South Treatment Plants. Onsite composting is a feasible option, though not recommended. The County already has an existing method of handling composting biosolids. Also, the additional capital and O&M costs associated with the composting equipment described in the Carnation Plan is anticipated to exceed the costs incurred by transporting one truckload of sludge cake every week across the County.

100-year Floodplain and Facility Layout

The layout for the proposed Carnation TP was changed and moved out of the 100-year floodplain of the Snoqualmie River. Figure 5 shows the new layout for the facility.



LEGEND:

A – HEADWORKS
B – OPERTAIONS BUILDING
C – FUTURE ANAEROBIC BASIN
D – FUTURE ANOXIC BASIN
E – FUTURE ANAEROBIC BASIN
F – FUTURE ANOXIC BASIN
G – FUTURE ANAEROBIC BASIN
H – FUTURE ANOXIC BASIN
J – AEROBIC ZONE 1
K – AEROBIC ZONE 2
L – AEROBIC ZONE 3
M – AEROBIC ZONE 4
N – FUTURE AEROBIC ZONE 5
O – FUTURE AEROBIC ZONE 6
P – CLARIFIER
Q – CLARIFIER
R – FUTURE CLARIFIER
S – SLUDGE PUMP STATION
T – SAND FILTER
U – SLUDGE HOLDING TANK
V – LOADING\BELT FILTER PRESS BUILDING
W – UV DISINFECTION STRUCTURE

1"=100'
0019–460–002

King County

HDR
HDR Engineering, Inc.

PROPOSED CARNATION
WASTEWATER TREATMENT PLANT

PRELIMINARY SITE PLAN

Date
SEPT 2001

Figure
5

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Other Issues
The addition of facilities for water reuse was not considered in the revised design. While is it anticipated that the addition of water reuse will be required in the future, there is currently insufficient number of industrial uses in the immediate service to justify the implementation of this type of treatment for Phase A development.

County facilities are generally expected to last several decades. Thus, the use of long lasting and high quality concrete, cement mortar units, and brick, will be favored over less durable materials. Also, any new facility built for the County will incorporate numerous architectural and landscaping details that will help blend the facility with the local environment. Examples of such work at existing County treatment plants include the construction of trails, marshes, and styled retaining walls at the West Point Treatment Plant and the outdoor Water Works Garden at the South Treatment Plant.

Monitoring and operational control of the proposed treatment plant will be available onsite with additional monitoring at the South Treatment Plant's control center through remote telemetry.

Environmental and Permitting

Environmental and Permitting issues for the treatment plant alternative are discussed in the following report section Environmental Conditions.

Capital Costs

For reasons to be listed in the Implementation Schedule section later in this report, the proposed treatment plant should be constructed to immediately accommodate Phase B flows and loadings. The construction and project costs associated with constructing this larger facility are listed in Table 11 and 12 respectively. Biological phosphorus removal and odor control were not included in the cost estimates. Construction costs of the revised treatment plant were estimated with the cost estimation program W/W Costs (ver. 3.0) using January 2000 ENR cost indices and refined through cost comparison with previous projects of similar size. The output of the model is found in Appendix C.

It appears that there was a significant discrepancy between the estimates in the Carnation Plan and the ones generated by W/W Costs. Since the Carnation Plan did not document the method of accessing the facility's Phase B capital costs, it was not possible to reconcile this difference.

Table 11. Proposed Phase B Carnation TP Construction Cost Estimates

Parameter	Phase B Construction Cost Estimates	
	Carnation Plan	Recommended Plan
Influent structure (screens and grit removal)	$121,000	$292,000
Aeration basins and equipment	$380,000	$895,000
Clarifiers and flow distribution box	$310,000	$348,000
Sludge pumping station	$305,000[(1)]	$316,000
Effluent filtration building and equipment	$284,000	$471,000
UV light structure and equipment	$95,000	$358,000
River outfall	$60,000	$92,000
Sludge belt filter press	$260,000	$743,000[(2)]
Sludge holding tank	$0[(1)]	$141,000
Admin/lab/maintenance building	$160,000	$171,000
Sitework and interface piping	$232,000	$689,000
Standby power and instrumentation	$297,000	$957,000
Contractor overhead and profit	$315,000	$547,000
Project construction cost	**$3,442,000[(3)]**	**$6,020,000**

Notes:

[(1)]: Carnation Plan combined all sludge pumping and storage equipment into one lump sum.

[(2)]: Installation of the belt filter press can be delayed to Phase C if desired.

[(3)]: Total differs from the sum of costs in Carnation plan by $9,000 due to a calculation error in the original costs.

Table 12. Phase B Carnation TP Project Costs for King County

Project Cost Item	Cost
Phase B construction	$6,020,000
Tax and construction contingency	$518,000
Engineering	$1,204,000
Construction management	$772,000
CIP labor	$617,000
Other labor	$391,000
Other fixed costs	$60,000
Land ROW	$96,000
Project contingency	$981,000
Total project cost	**$10,610,000**

Water Reuse Facilities Construction Costs
Tables 11 and 12 do not include the cost of installing the additional facilities for the production of Class A reclaimed water. The Carnation Plan listed a construction cost for this component as $296,000. This cost would provide a system large enough to handle flows for Phases B and C of plant development. Inputting these construction values into the County budget model produced additional project cost of $583,000 for water reuse.

Since the revised plan did not consider this item, no W/W Cost construction estimate was developed. However, it is suspected that given the previous pricing information, the cost estimate produced for this system by the computer program may be significantly higher than the capital costs listed in the Carnation Plan.

Operations and Maintenance Costs

According to the Carnation Plan, Phase B of the proposed treatment plant would require one Class 1 operator and one Class 2 operator. The Carnation Plan's annual labor cost for the two-person staff would be $78,000.

The W/W Cost model estimated that the Phase B treatment plant would require 6,984 hours to operate the facility. Productivity studies previously conducted at King County estimated that wastewater treatment plant staff dedicated only 1,570 hours/person/year to the actual operation of the facility; the remaining time spent on vacations, holidays, training, and other commitments. Using this value, the proposed Carnation TP would require 4.45 or five people to be fully staffed. If the County is the lead agency, it is anticipated that the staffing could be reduced to three people due to the installation of remote telemetry control and additional maintenance support from the East Division Offsite Facilities crew.

One person would be rated as Class 2 operator while the other two would be Class 1 operators. The operators primary task would be the routine maintenance of the proposed facility. The monitoring of plant operations would primarily be handled by the operators of the South Treatment Plant using remote telemetry if the County is the lead agency.

Assuming that the average cost of the Class 2 and Class 1 KCWTD treatment plant operators are $35.00/hour, the labor cost for the proposed plant would be $218,400. The total cost include the operators' direct pay, fringe benefits, and other administrative costs. Besides the additional person, it is believed that the order of magnitude difference between the two labor estimates were due to the Carnation Plan did not sufficiently address the operators' benefits and overhead costs. The annual materials and electrical costs also differed significantly between the Carnation Plan and the W/W Cost estimates for the revised plan. Table 13 shows the estimated O&M costs.

Table 13. Estimated Annual O&M Costs for Phase B of the Proposed Carnation TP with Liquid Sludge Hauling

Operational Cost Item	Carnation Plan	Revised Plan
Labor and administration	$76,000	$218,000
Materials (including chemicals)	$25,000	$60,000
Electricity	$29,000	$31,000
Liquid sludge disposal at the South Treatment Plant	$29,000	$112,000
Total annual O&M cost	**$159,000**	**$421,000**
Note: Values in year 2000 dollars.		

The calculation of the hauling and disposal cost of liquid sludge disposal in the Carnation Plan was not documented and so it was unknown how the quoted cost of $25,000/year was obtained. Using the revised plan, sludge production would be 5,700 gpd of 1.5 percent sludge. To determine the cost of sludge disposal, it was assumed that one tanker truck full of biosolids would be sent to the South TP for treatment, a round trip of 64 miles, on a daily basis and the cost of transport was $0.325/mile. The annual internal cost for treatment and disposal was assumed to be $0.05/gallon. Using these assumptions, the annual liquid sludge disposal cost would be $112,000. The actual treatment cost at the South TP varies significantly on a daily basis due to fluctuating energy prices.

If the Carnation TP was to install the belt filter press for Phase B, the materials and electrical costs will increase slightly. However, the cost increase would be offset by the large decrease in biosolids transport and disposal costs since . The dewatered sludge was assumed to be shipped to GroCo, Inc. in Kent, a 78 miles round trip. GroCo currently charges the County approximately $35 per wet ton ($28 per cubic yard).

Table 14 Estimated Annual O&M Costs for Phase B of the Proposed Carnation TP with Biosolids Disposal at GroCo

Operational Cost Item	Revised Plan
Labor and administration	$218,000
Materials (including chemicals)	$62,000
Electricity	$35,000
Biosolids disposal at GroCo Inc.	$30,000
Total annual O&M cost	**$345,000**
Note: Values in year 2000 dollars.	

O&M costs associated with the removal of biological phosphorus and water reuse were omitted from the Carnation Plan. It is not known why these costs were not included in the report of the original design. Since the revised plan does not include these processes, the O&M costs for biological phosphorus removal and water reuse were not developed using W/W Costs.

Implementation Schedule

Since the plant would be discharging into a water body with known salmonid populations, a permit would need to be issued by the U.S. Army Corp of Engineers (USACE). For this permit to be issued, the agency would require concurrent opinions regarding ESA impacts from the National Marine Fisheries and the Washington State Department of Fish and Wildlife. Currently, it is estimated that obtaining any USACE permit would take between one and two years, with a treatment plant outfall permit requiring at least 18 months. A preliminary schedule for the proposed treatment plant is included in Figure 6.

The construction of the treatment plant would take between 12 and 18 months, depending upon the time of year it was started and the weather conditions. While projects of this size would typically take longer, the proposed plant would need less time for construction due to the reliance of package systems for the majority of the facility and the site of the plant is not occupied with any existing structures.

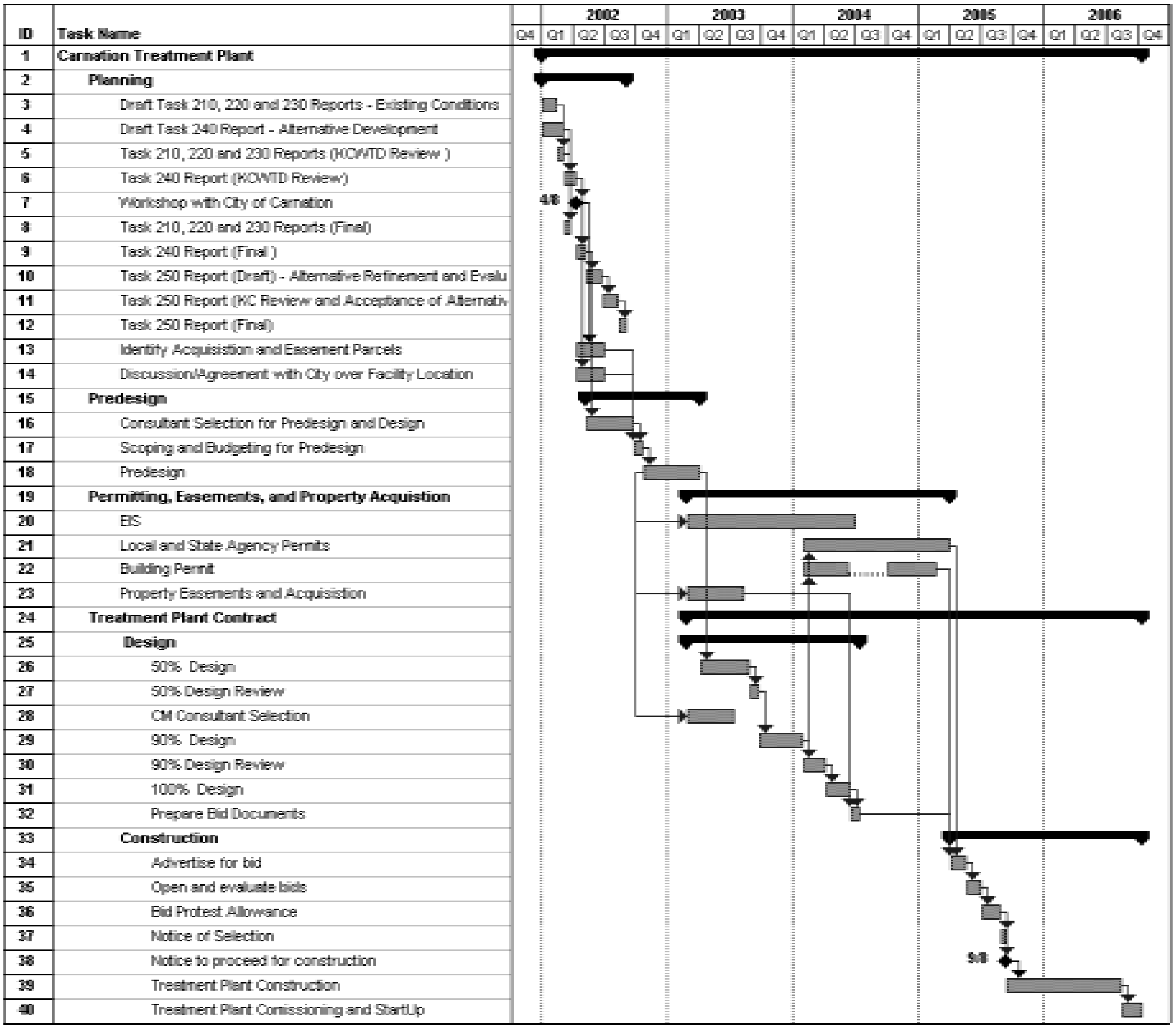

Figure 6. Proposed Carnation TP Implementation Schedule

The Carnation Plan had anticipated that the Phase A treatment plant would be operational by 2003 with Phase B expansions completed by 2008. Revising the schedule to include County planning and design requirements and the USACE permitting process would make the entire project to last about five years. If the project was started on January 2002, the proposed plant would be fully operational by late 2006, two years before Phase B expansions would need to be online. Given the scheduling conditions, construction of the proposed facility to meet Phase B conditions would most likely be more preferable than constructing the treatment plant in two stages.

Construction of a treatment plant capable Phase B flows and loadings, instead Phase A, should not change the schedule appreciably due to the small size of the overall facility. Implementing biological phosphorus removal or water reuse immediately would increase the design and construction times, though it is anticipated that the total construction time should stay in the 12 to 18 month range.

Environmental Conditions

This section provides an overview of the existing environmental conditions, ESA-related issues and other environmental consequences, and the likely implications for providing wastewater service to the City of Carnation.

Conveyance Alternatives

Existing Habitat

Wildlife Habitat

The five proposed wastewater conveyance lines for the City of Carnation traverse a variety of habitats that support numerous species of wildlife, including federal and state endangered, threatened, and protected species. Wildlife species near a given route could include songbirds, red-tailed hawk, bald eagle, heron, deer, coyote, etc.

Within the City of Redmond, six active and five non-active red-tailed hawk (*Buteo jamaicensis*) nests were documented in 2000. An active great blue heron (*Ardea herodias*) colony and an active bald eagle (*Haliaeetus leucocephalus*) nest were also documented in 2000 (Adolfson Associates, 2000).

Fish Habitat

Five potential conveyance routes have been proposed as part of the County's Carnation CSI project. These proposed routes traverse portions of thirteen basins as designated in the King County Sensitive Area Map Folio (1990). These basins include Big Bear Creek, Evans Creek, Ames Lake, Snoqualmie River, Griffin Creek, Patterson Creek, Raging River, Issaquah Creek, North Fork Issaquah Creek, East Fork Issaquah Creek, and Tibbetts Creek. Figure 7 illustrates the tributaries/streams and rivers that could potentially be affected by construction of a conveyance pipeline along one of the five proposed route alternatives.

Snohomish River Basin (WRIA 7). WRIA 7 includes the Ames Lake, Snoqualmie River, Griffin Creek, Patterson Creek, and Raging River basins as mapped in the King County Map Folio (1990). One or more of the proposed conveyance system routes traverses portions of each of these basins. Chinook, coho, pink, and chum salmon spawning occurs in the main stem Snoqualmie River and the lower Tolt River. Chinook and coho also use the Raging River. Very little chum salmon spawning occurs in the Snoqualmie River tributaries. Chinook, coho, chum, and pink salmon spawn and rear in the main stem above river mile (RM) 21.0, while coho and chum spawn and rear in Ames Creek. Chinook salmon migrate, spawn, and rear in the section of the Raging River within the project area (below RM 7.0), and coho inhabit the entire accessible river and tributaries (Williams et al., 1975). Coastal cutthroat are found throughout the Snohomish River Basin, including the main stem Snoqualmie River, and nearly all its tributaries, including the Raging River, which is a major producer (WDFW, 2000).

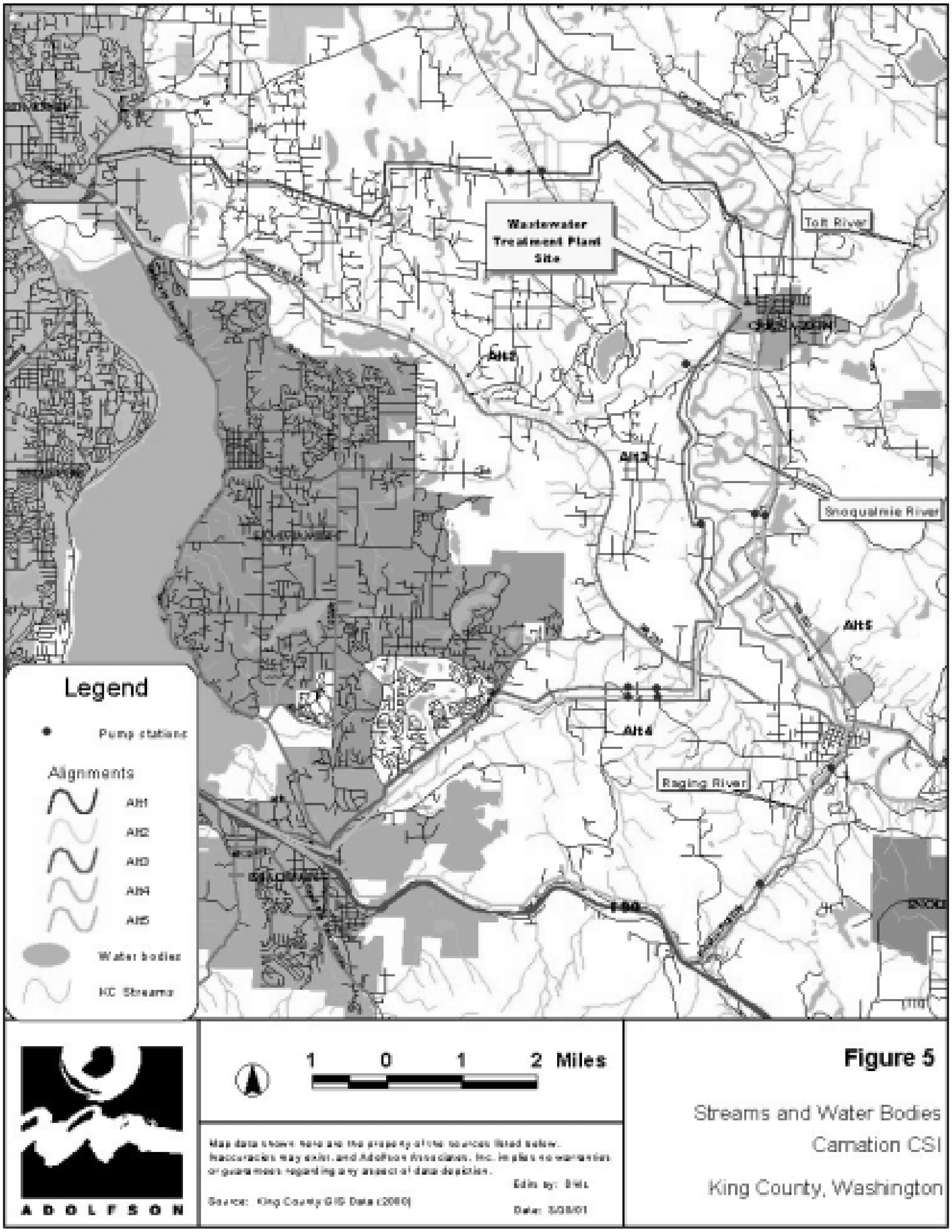

Figure 7. Streams and Water Bodies

Lake Washington Basin (WRIA 8). WRIA 8 includes the Big Bear Creek, Evans Creek, Issaquah Creek, North Fork Issaquah Creek, East Fork Issaquah Creek, and Tibbetts Creek basins as mapped in the King County Map Folio (1990). One or more of the proposed conveyance routes traverses portions of each of these basins.

Chinook, coho, and sockeye salmon as well as steelhead and sea-run cutthroat trout utilize the drainages of the Lake Washington Basin. Chinook salmon spawning and rearing occurs in the larger Lake Sammamish tributaries including Issaquah and Big Bear Creeks (Williams et al., 1975). Coho salmon utilize virtually all accessible streams within this basin. Coho spawn in the potentially affected Sammamish River drainages including Issaquah, Tibbetts, Evans, Big Bear, and Bear Creeks. Rearing coho are found in nearly every accessible tributary stream within this basin (Williams et al., 1975). Adult sockeye salmon are known to utilize the Issaquah Creek and Big Bear Creek drainages, however some sockeye spawning occurs in virtually all accessible drainages within this basin. Sockeye juveniles rear throughout the accessible length of the basin streams (Williams et al., 1975).

Hazard Areas

Erosion Hazards

The susceptibility of any soil type to erosion depends upon the physical and chemical characteristics of the soil, its vegetative cover, slope length and gradient, intensity of rainfall, and the velocity of water runoff. The King County Sensitive Areas Ordinance defines those areas as those soils in King County that may experience severe to very severe erosion (King County, 1990).

The King County *Sensitive Areas Map Folio* (1990) has identified several erosion hazard areas in the project area (Figure 6) associated with steep slopes. Significant erosion in the area is most likely to occur along steep slopes along the west bank of the Snoqualmie River in the Carnation area, the Raging River basin, North Fork Issaquah Creek, and East Fork Issaquah Creek.

Landslide Hazards

Landslide hazard areas are defined as areas that have a greater than 15 percent slope gradient, impermeable soils, and groundwater seepage. Areas with a history of rapid stream incision, stream bank erosion, or undercutting by wave action were also designated, as well as areas with a geological history that would indicate landslide susceptibility (King County, 1990). The King County *Sensitive Areas Map Folio* (1990) identifies landslide hazard areas within the project area (Figure 8). These locations include slopes within the Ames Lake basin, along the Snoqualmie River west and north of the City of Carnation, along the Raging River, and locations along the East Fork of Issaquah Creek.

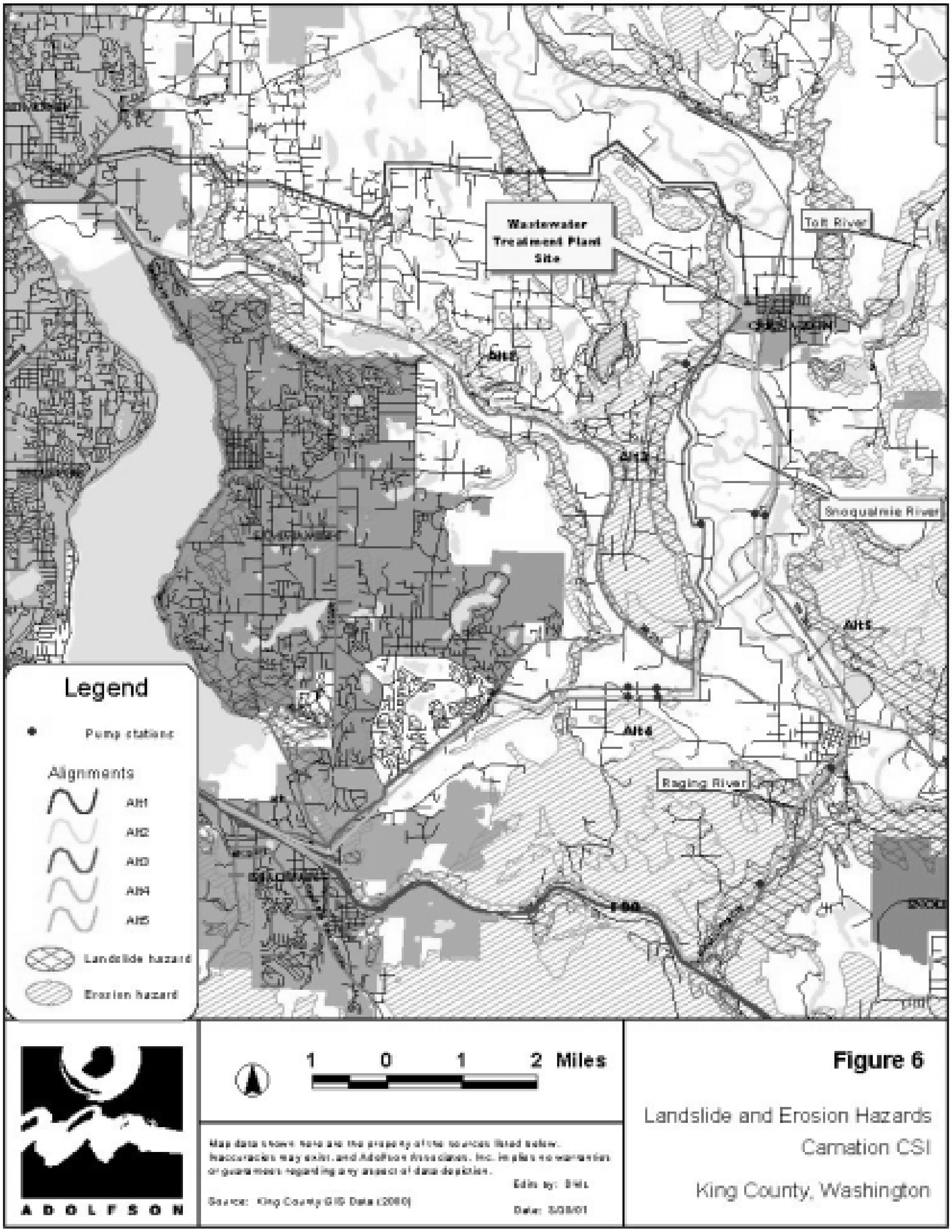

Figure 8. Landside and Erosion Hazards

Seismic Hazards
Seismic hazards are defined as those areas subject to severe risk of earthquake damage as a result of settlement or soil liquefaction. These conditions occur in areas underlain by soils with low cohesion and density, usually in association with a shallow groundwater table. When shaken by an earthquake, certain soils lose their ability to support a load. Loss of soil strength can also result in failure of the ground surface and damage to structures supported in or on the soil. Loose, water-saturated materials are the most susceptible to ground failure due to earthquakes (King County, 1990).

The King County *Sensitive Areas Map Folio* (King County, 1990) identifies a significant portion of the Snoqualmie River basin as susceptible to seismic damage (Figure 9). Areas within the Bear Creek, Evans Creek, and Patterson Creek basins were also identified as susceptible to seismic damage as are areas along the Raging River south of Fall City and a portion of the East Fork Issaquah Creek near Preston.

Flood Hazard Areas
The King County *Sensitive Areas Map Folio* (1990) documents the potential flood hazard areas within the Project Area. The flood hazard areas are located within a 100-year floodplain, defined as an area that has a one percent probability of inundation in any given year.

Flood hazard areas within the project area mainly occur along the Snoqualmie and Tolt Rivers. The Snoqualmie River has an extensive 100-year flood plain and ranges from approximately 0.10 to 1 mile from the river. Less extensive flood hazard areas exist in conjunction with Bear Creek, Evans Creek, Patterson Creek, North Fork Issaquah Creek, East Fork Issaquah Creek, and the Raging River (King County, 1990) (Figure 10).

Construction Considerations

Most of the environmental considerations and permit requirements for conveyance system improvement projects arise from potential construction impacts to wetland and stream resources. Proposed routes that impact streams and wetlands often require additional permitting effort, particularly if the wetland or stream occurs in a basin with known or suspected use by ESA listed fish species. Each alternative pipeline route crosses a number of streams, wetlands, and/or buffers. A summary of the number of potential crossings is provided below in Table 15.

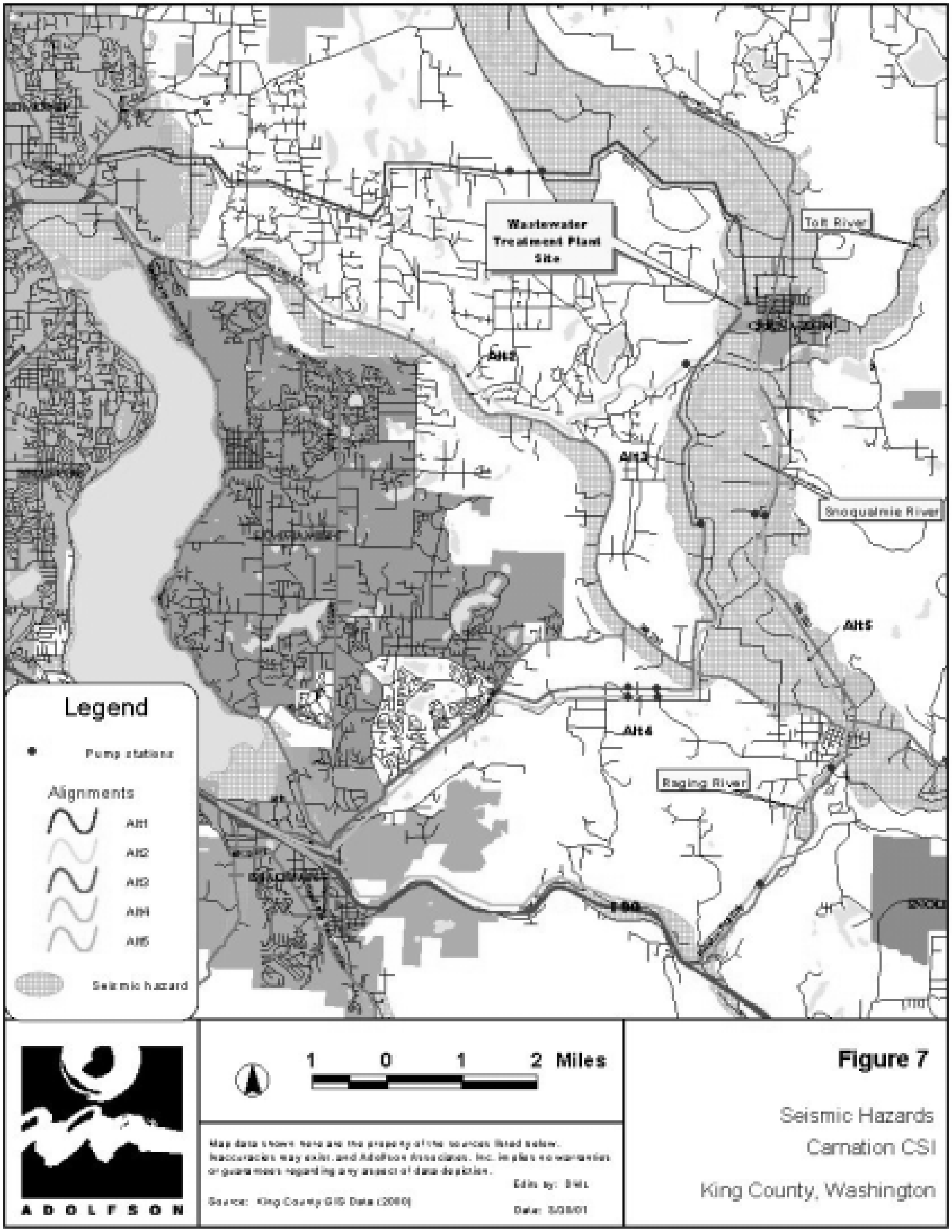

Figure 9. Seismic Hazards

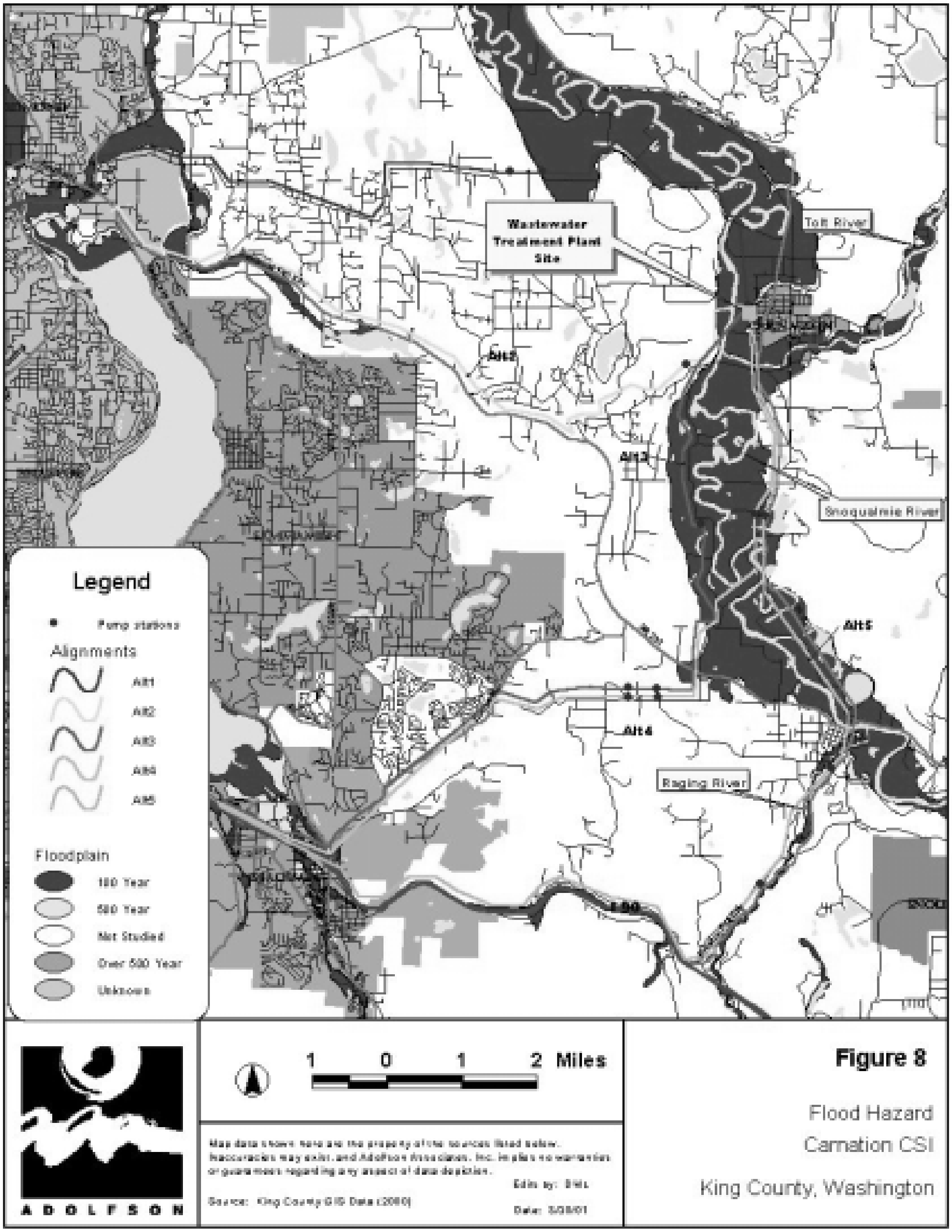

Figure 10. Flood Hazard

Table 15. Number of Potential Pipeline Crossings

Proposed Alignment	Potential Wetland Crossings	Potential Stream Crossings
Alternative 1	7	8
Alternative 2	10	4
Alternative 3	13	12
Alternative 4	14	15
Alternative 5	17	33

Wetlands

Each alternative pipeline route crosses a number of documented wetlands and/or wetland buffers (Figure 11). Most wetlands would be crossed using open-trench construction methodologies. Other crossing methods, such as micro-tunneling or horizontal directional drilling, may be employed in certain circumstances, but for the purpose of this evaluation, open trench construction is assumed to be the method to be used for wetland crossings. In addition to trenching, construction impacts to wetlands may also result from vegetation clearing in wetlands, construction of temporary access roads, and the stockpiling of spoils, pipe, and bedding material.

Impacts to wetlands from conveyance system improvements are typically short-term in nature if the construction corridor is properly restored following installation. Long-term effects are most often a result of clearing in forested wetlands or other unique wetland systems like bogs. The re-establishment of trees or slow-growing bog vegetation can take many years. This is a particular consideration for the Carnation project since the Sammamish Plateau/Novelty Hill area supports many large forested wetlands and bogs or bog-like wetlands. An additional long-term effect could result from changes to the hydrologic regime of the wetland and any streams that are hydrologically supported by the wetland because of construction. A common concern among regulatory agencies is that the pipe and trench may act as a curtain drain and intercept or depress the groundwater table along the alignment. This concern may even arise for projects that do not directly impact a wetland, but parallel a wetland area up-slope from the wetland.

Stream Impacts

Each alternative route involves a number of stream crossings. Based upon the route information developed to date, Alternative 1 involves eight crossings, Alternative 2 involves four crossings, Alternative 3 involves 12 crossings, Alternative 4 involves 15 crossings, and Alternative 5 involves up to 33 crossings. It should be noted that these estimates represent a worst case scenario, and some of the crossings could likely be avoided by minor routing alignment alterations.

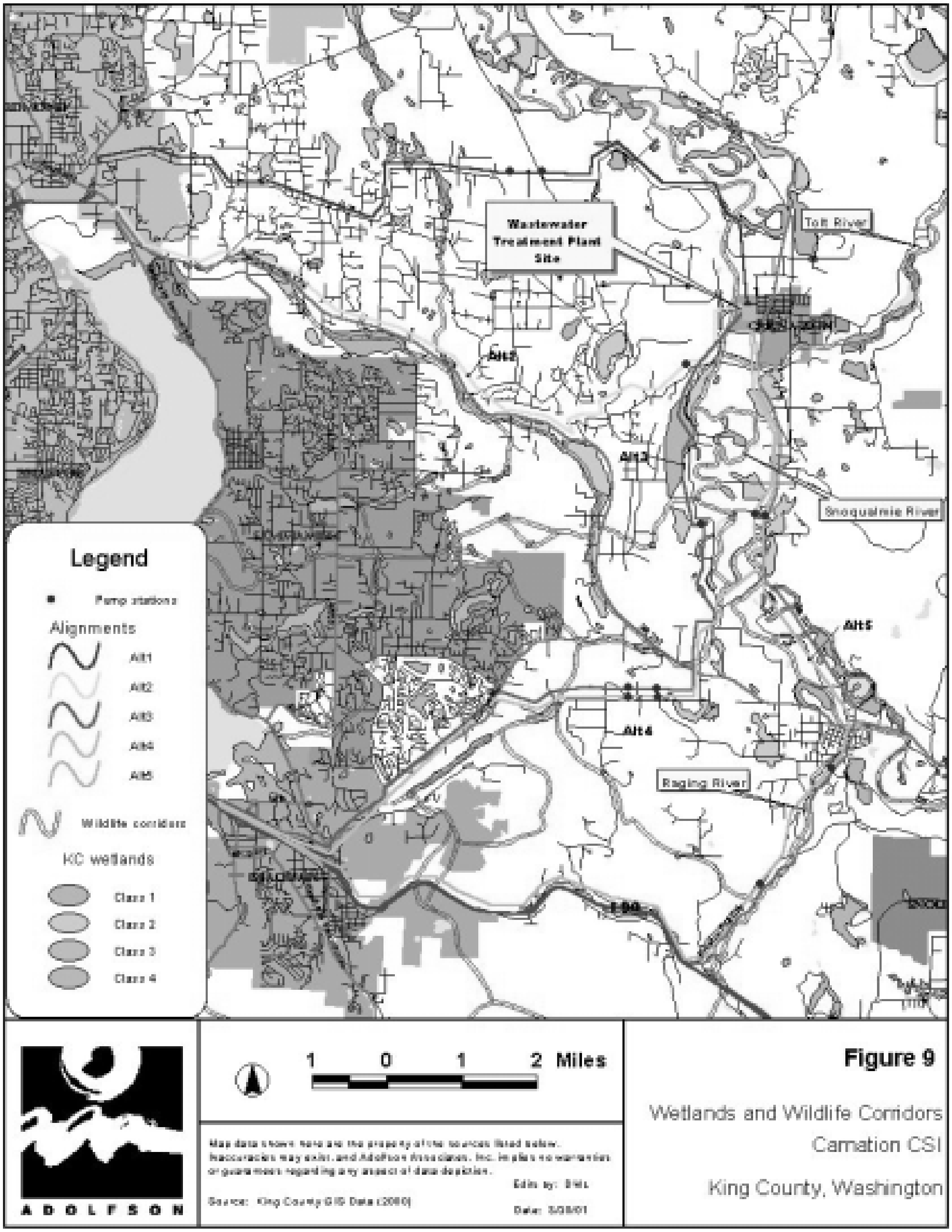

Figure 11. Wetlands and Wildlife Corridors

Stream crossing methods commonly involve one of several methods: jacking and boring, microtunneling, directional drilling, or open-cut trench construction. The levels of impacts vary by construction method. A summary of each method related to environmental issues is shown in Table 16.

Table 16. Environmental Issues Regarding Pipe Installation Methods

Method	Positives	Negatives	Comments
Jack and bore	No or limited impact to stream bed or banks. Provides access to obstructions for removal via casing.	Requires large pits adjacent to stream riparian corridor. May require dewatering channel if high water table.	Issues with construction of pits in riparian area may be negligible if pits can be located in roadways, roadside areas, or disturbed areas.
Microtunneling	No or limited impact to stream bed or banks. Can traverse longer distances between pits than jack and bore	Requires large pits. May require dewatering channel if high water table. Does not allow access to face. May require alternate method if not successful.	Low level of predictability for stream crossings where extensive geotechnical work is precluded by desire to limit impacts to stream.
Directional Drilling	Does not require large jacking or receiving pits. Does not require dewatering. Can be used over long distances reducing need to impact riparian areas	Requires use of high pressure drilling fluid. May require alternate method if not successful.	Drilling fluid is typically non-toxic bentonite; however, can result in impacts to stream bed and increased turbidity of released to stream via overflow from receiving pits or fractures.
Open Cut	Most predicable method related to impact assessment. Typically shortest construction time.	Requires dewatering and direct disturbance to stream bed. Short-term turbidity increases when water is reintroduced. May result in channel dewatering if trench not properly plugged.	Often the method of last resort

There are five primary impact pathways that could directly affect streams and ESA-listed fish species depending on the crossing method or combination of methods. The first and most significant impact occurs when a portion of stream must be dewatered. Stream channel dewatering may be required by the need to divert or bypass the stream around or through a work area to facilitate open cut, jack and bore, or micro-tunnel construction. The second effect is related to increased potential for erosion and sedimentation because of soil disturbance necessary to construct pits or from other construction in proximity to the streams or adjacent riparian areas. The third effect is related to the construction-related discharges of water pumped from the pits or nearby trench sections. The forth effect is related to the potential for spills or releases of hazardous materials during construction in proximity to streams. The fifth effect is related to clearing and grading. Most impacts from pipeline crossings are temporary in nature and usually are limited to construction-related impacts; however, given the sensitivity of aquatic organisms to degradation, even short-term impacts can be significant.

Wildlife Habitat Impacts

Known wildlife corridors in the area are depicted on Figure 9. There is potential for some of the red-tail hawk nests to be near construction activities for conveyance pipeline Alternatives 1 and 2. Additional project-specific analysis would be necessary following the selection of a pipeline route alternative and commencement of construction. Construction activities will need to comply with local and county regulations with respect to buffers around nesting areas to minimize impacts to nesting birds.

Transportation

Construction within road and highway rights-of-way would unavoidably increase traffic congestion, which is an existing problem in portions of the project area. The majority of the conveyance pipeline for a given route alternative would be installed primarily within road or highway right-of-way. Construction of the pipeline would occur at rate of approximately 100 to 300 feet per day. Disruption to traffic flow would occur with any alternative and could include a reduction in the number of lanes, closures of roadway sections and detours, and temporary traffic delays. Mitigation measures would have to be incorporated to minimize adverse impacts during construction. The proposed routes and the major highways and roads within the project area that would be affected by pipeline construction are listed in Table 17.

Table 17. Potentially Affected Roadways

Conveyance Route Alternative	Potentially Affected Roadways
Alternative 1	Duvall Carnation Road NE NE Carnation Farm Road Ames Lake-Carnation Road NE NE 80th Street Union Hill Road Avondale Way
Alternative 2	NE Tolt Hill Road Redmond-Fall City Road
Alternative 3	W Snoqualmie River Road NE E Main Street SE 24th Street 309th Avenue SE 308th Avenue SE SE 40th Street Issaquah-Fall City Road
Alternative 4	Fall City-Carnation Road NE (SR-203) 308th Avenue SE SE 40th Street Issaquah-Fall City Road
Alternative 5	Fall City-Carnation Road NE (SR-203) Fall City-Carnation Road SE (SR-203) Preston-Fall City Road SE SE High Point Way

Permitting Considerations

Wetland Permits

Conveyance system improvements that impact wetlands trigger the need for permit compliance at the local, state, and federal levels. Within King County, projects that impact wetlands are subject to the requirements of Chapter 21A of the King County Code (or local jurisdiction code). A wetland special study is required for all projects that impact wetlands or their buffers. King County regulations also require that disturbed wetlands and buffers be restored. At the state and federal levels, most pipeline projects with wetland impacts are permitted under the Section 404/401 Nationwide Permit System. The USACE and the Washington State Department of Ecology (WDOE) are the federal and state agencies, respectively, with jurisdiction over most conveyance projects that impact wetlands. Depending on the circumstance, projects that impact wetlands may also be regulated by the State Hydraulic Code and may require a Hydraulic Project Approval (HPA) by the Washington State Department of Fish and Wildlife (WDFW).

Nationwide Permit 12 has been authorized to allow the construction of up to 500 linear feet of pipeline within wetlands. Projects with wetland impacts over 500 linear feet must be permitted following the Individual Permit process. There are many differences between the Nationwide and Individual permit pathways; however, the most significant is that the USACE may require the preparation of an alternatives analysis for Individual Permit project. An alternatives analysis may be required to show that the proposed project has fewer environmental impacts than other viable alternatives. Both the Nationwide and Individual permit process trigger Endangered Species Act Section 7 consultation and National Historic Preservation Act Section 106 consultation.

Stream Crossing/ESA Permits

Commonly, conveyance system improvements that impact stream or riparian areas trigger the need for many of the same local, state, and federal permits and approvals as projects that impact wetlands. As with projects that affect wetlands, projects that impact streams within the County are subject to Chapter 21A of the King County Code (or local jurisdiction code) and a stream special study may be required. At the state and federal level, most pipeline projects with streams are permitted under the Section 404/401 Nationwide Permit System as discussed above for wetlands; however the WDFW HPA is almost always required for projects that directly impact streams. Nationwide Permit 12 has been authorized to allow the construction of up to 500 linear feet of pipeline within streams. Projects with wetland impacts over 500 linear feet of stream impacts must be permitted with an Individual Permit with the same requirements discussed above in the wetland section. The need for a USACE permit triggers Endangered Species Act Section 7 consultation and National Historic Preservation Act Section 106 consultation for work in both wetlands and/or streams. A possible exception to the need for USACE permit is for stream crossings that do not require in-water work, stream diversion or dewatering, or that do not otherwise impact wetland areas. In these instances, a USACE nexus may be avoided and a Section 7 review would not be required unless the project included involvement from another federal entity in relation to other project elements.

Most permits require the restoration of the disturbed portions of stream bank and stream bed to pre-existing conditions. The most common effect of ESA planning and permitting on construction is generally related to the implementation of in-water work windows. In water work, windows commonly regulate not only construction that affects wetted areas of the stream, but any area below the ordinary high water mark of drainage. For streams with wide floodplains or large associated riparian wetlands, this may include a larger area than just the region between the banks of the stream. Work windows vary depending on the basin and are commonly adjusted by the permitting agencies depending on the type of work and the fisheries resources within each stream. Typically, fresh water work windows range from mid-June through mid-September but may be as short as July 1 through August 30 for streams with significant juvenile and adult use. Work windows may also extend to mid-October for smaller headwater streams that generally support populations of coho salmon and resident cutthroat trout. Work windows are commonly set as a condition of the WDFW HPA; however, NMFS and/or the USACE may require slightly different work windows to further reduce impacts to listed fish if applicable.

Given the length of the pipeline routes, the potential for impacts, and the number of stream and wetland crossings, permitting for the pipeline portion of this project would likely take up to one year once applications have been submitted to the agencies.

LOCAL TREATMENT ALTERNATIVES

Environmental and Permitting Considerations

The proposed treatment plant site location (see Figure 1) is owned by the City of Carnation and meets the necessary engineering criteria.

Treatment Plant Construction
Construction of a treatment plant would have similar impacts to those described for the conveyance alternatives above; however, construction impacts would be concentrated at the treatment plant location. The proposed treatment plant site is located in the 100-year floodplain of the Snoqualmie River. Approvals for this project would require coordination with the Federal Emergency Management Agency (FEMA), a King County Shoreline Substantial Development Permit, and a Conditional Use Permit.

Wastewater Discharge
Construction of an outfall would have similar impacts to those described above for open cut trenching within a stream, with temporary increases in turbidity, but longer-lasting effects from siltation and channel instability. Construction would be limited to the allowed fish windows as described above.

Discharge from the treatment plant is proposed for the Snoqualmie River. Wastewater would be treated to Class A standards prior to discharge. Even with this high level of treatment, there are still potential water quality concerns. Potential water quality concerns related to treated wastewater that may require further investigation include elevated temperatures, low dissolved oxygen, increased nutrients, and increased levels of bacteria, among other parameters. The discharge of metals, particularly copper, may be a concern for the Snoqualmie River system. The concentration at which copper becomes toxic to fish is highly dependent upon receiving water hardness, pH, and alkalinity. Relatively low levels of dilution during summer months may exacerbate the effects of some constituents. Emerging issues, such as endocrine disrupters may also be a concern.

Overall, water quality conditions in the area may improve by providing wastewater treatment in lieu of increasing on-site sewage system use and aging systems that are either failing or are approaching failure. Treated effluent may result in a positive impact to the freshwater systems by increasing low summer flows. Temperature is of concern in the Snoqualmie River during the summer months. Discharges to the Snoqualmie River may require extensive monitoring prior to (a minimum of one year) and following implementation to ensure that water quality was not being degraded and water quantity was not resulting in downstream impacts. Studies of fish populations in the discharge reach may be necessary to establish acceptable discharge limits. Studies would likely focus on summer low flow periods, since this is a critical time for rearing salmonids.

NPDES Permit

The discharge of wastewater into Washington State surface waters is regulated through the National Pollutant Discharge Elimination System (NPDES) permitting process, issued by the Department of Ecology (Ecology) under authority delegated by the US Environmental Protection Agency. Individual permits, which cover single, specific facilities or activities, are typically issued for wastewater discharges from municipal wastewater treatment plants. Permit applications require information on factors including supply volumes, water utilization, wastewater flow, wastewater characteristics and disposal methods, plant operations, and chemicals used. NPDES permits generally take up to one year, depending upon the complexity of the project, and must be renewed every five years. Given the required monitoring prior to the permit application, anticipated concerns by regulators, tribal considerations, and endangered species considerations, permitting for this project could take at least two years, and likely three to four years. Permitting outcome is uncertain given the fisheries considerations, particularly ESA concerns.

ESA Considerations

The ESA requires that federal agencies consider potential impacts to listed species resulting from actions that are interrelated to, or interdependent on, the primary project. Federal agencies often scrutinize sewer and road projects because of the potential for “urbanization” to affect the character of nearby waterways resulting in adverse effects to fish and other aquatic organisms within nearby streams. It is possible that until the effects of urbanization are addressed on a regional basis, either through approved provision included via the Section 4(d) rulemaking process or through an approved Habitat Conservation Plan, NMFS and USFWS will continue to evaluate potential interrelated and interdependent actions on a project-by-project basis.

A particular challenge with this process will be obtaining the necessary ESA-related approvals for a new outfall into chinook habitat areas of the Snoqualmie River. It is not, however, an impossible undertaking within the context of the valuation of potential effects on listed fish species as part of a larger system-wide environmental review such as may occur during the SEPA process. This process would examine and contrast the impacts associated with no action against providing centralized wastewater treatment services.

An additional challenge under the ESA will be the potential long-term water quality impacts, particularly temperature increases that could occur in the river. It will be essential for the proposed facility to provide emergency capabilities in the event of power failure, flooding, and other catastrophic events to prevent significant impacts to listed species.

FINANCIAL CONSIDERATIONS

Rates and Customer Charges

The construction, operation and maintenance of the proposed Carnation facilities will be supported through a combination of the regular revenues of the King County Wastewater Treatment Division and the revenues from the monthly rate and other charges paid by the prospective Carnation customers. These charges would include the regular monthly sewer rate, and a special surcharge applied to Carnation customers. This surcharge, specified as a percentage of the regular monthly sewer rate in this analysis, is designed to recover the additional capital-related costs incurred in the construction of facilities for Carnation. The operations and maintenance costs of the King County-constructed facilities are assumed to be covered by the revenues from the regular monthly rate payment of Carnation customers.

In the sections below, the monthly cost to Carnation customers is estimated based on the recently passed monthly sewer rate of $23.40 for 2002. This is for illustration purposes as the King County Executive sets the King County Sewer Rate annually to reflect the monetary requirements forecast and can be expected to vary.

Financing Resources

There are a number of resources available for financing the costs associated with any new facilities, including revenue bonds, low interest loans, outright grants and combinations of all three.

Four alternative financing arrangements are presented for each of the six capital project alternatives. These financing alternatives are not intended to provide the definitive estimate of the monthly costs associated with each of the six capital alternatives, but to provide a consistent set of estimates to compare across alternatives and to provide the base for further discussion. Further, these alternatives are not meant to be exhaustive as there are other potential sources of funds and permutations of the alternatives. These were chosen as presenting a range that provides a framework to further discussion and analysis. The alternatives are:

- Full financing through King County Wastewater Treatment Revenue Bonds,
- Washington State Pollution Control Revolving Fund Loan for construction-related costs with revenue bonds for the remainder,
- Public Works Trust Fund loan of $10 million with revenue bonds for the remainder, and
- Public Works Trust Fund loan of $20 million with revenue bonds for the remainder.

Table 18 summarizes the basic assumptions for each of the financing alternatives.

Table 18. Carnation Financing Alternatives

Assumptions			
Source	**Rate %**	**Term**	**Limits**
King County Sewer Revenue Bonds	5.5	35 years	Metropolitan King County Council Approval
State Revolving Fund Loan	1.5	20 years	Project Ready for Construction
Public Works Trust Fund Loan 2004	0.5	20 years	$10 million per biennium
Public Works Trust Fund 2004 and 2006	0.5	20 years	$20 million per biennium

For the purposes of this analysis, the probability of securing any outright grant funds was thought sufficiently uncertain as to sources, timing and amount that it is not included as an alternative. As the project becomes more defined, possible sources of these funds can be identified and included in the analysis. Any grant funds secured for the project would be fully applied to lowering the surcharge. If an agreement moves forward, King County will aggressively pursue these funding sources.

Financing Assumptions

It is assumed that the capital project schedules are not altered in response to potential requirements for a particular funding source. Financing needs are based on inflated project cash flows. The funds are secured in the year the cash is needed. The exception to this is when a low interest loan is secured and used to finance multiple year expenditures.

The surcharge is based on the net present value of the principal and interest payments incurred in constructing the facilities, over a 35-year period at a discount rate of 5.5 percent. These costs are then compared to the present value of the monthly sewer rate revenues from Carnation customers during the same period. The surcharge is expressed as a percentage of the rate revenues.

Financing Alternatives

In each of the financing alternatives, it is assumed each capital project has the same phasing schedule over the 2002-2007 period. Financing is based on inflated project costs and funds are secured in the year the cash flow is needed. The exception to this is when a low interest loan is secured is used to finance multiple year expenditures.

King County Sewer Revenue Bonds
In this scenario, the capital costs of the Carnation facilities are financed through King County Sewer Revenue bonds. These bonds are assumed to have a rate of 5.5 percent and a term of 35 years, in keeping with the current forecast assumptions of the King County 2001-2007 Financial plan. The costs that are recouped through the rate surcharge are only those associated the regular principal and interest payments, as any additional issuance costs have not been included. The details regarding using King County Sewer Revenue Bonds are listed in Table 19.

Table 19. Financial Details with using King County Sewer Revenue Bonds

Alternative	Surcharge rate %	Monthly Rate[1]	Monthly Surcharge	Total Monthly
Treatment Plant	158	$23.40	$36.97	$60.37
Conveyance Alt. 1	409	$23.40	$95.71	$119.11
Conveyance Alt. 2	378	$23.40	$88.45	$111.85
Conveyance Alt. 3	489	$23.40	$114.43	$137.83
Conveyance Alt. 4	489	$23.40	$114.43	$137.83
Conveyance Alt. 5	634	$23.40	$148.36	$171.76

(1): This is the adopted 2002 King County Sewer Rate

State Revolving Fund Loan
In this scenario, it is assumed the construction activity associated with the facilities will be financed through a low interest loan secured through the Washington Sate Water Pollution Control Revolving Fund (SRF). The SRF is a competitive source of funds available to projects that are ready for construction. For current purposes, it was assumed that these

funds would be applied to costs occurring in the fourth through sixth years of the project. The total loan amount from this source is not limited by policy so it is assumed that for each of the six capital alternatives, the full project costs incurred in 2005 – 2007 are borrowed in 2005. The interest rate for these loans is currently 1.5% for a period of 20 years. All remaining project costs not covered by the SRF are financed through King County Sewer revenue bonds at the terms specified in the sewer revenue bond section. Table 20 lists the various rates associated with this funding option.

Table 20. Financial Details with using 20-Year State Revolving Funds at 1.5% Interest

Alternative	Surcharge rate %	Monthly Rate[1]	Monthly Surcharge	Total Monthly
Treatment Plant	136	$23.40	$31.90	$55.30
Conveyance Alt. 1	354	$23.40	$82.73	$106.13
Conveyance Alt. 2	326	$23.40	$76.35	$99.75
Conveyance Alt. 3	423	$23.40	$98.95	$122.35
Conveyance Alt. 4	422	$23.40	$98.84	$122.24
Conveyance Alt. 5	548	$23.40	$128.26	$151.66

(1): This is the adopted 2002 King County Sewer Rate

Public Works Trust Fund, 2004

The Public Works Trust Fund (PWTF) Loan Program provides low-interest loans to a maximum of $10 million per biennium per jurisdiction. The loans carry a 0.5 percent interest rate for a term of 20 years, with a 15 percent matching requirement on the recipient. In this scenario, it is assumed that up to $10 million in loans can be secured in 2004. All remaining project costs not covered by the PWTF loan are financed through King County Sewer revenue bonds at the terms specified for the bonding scenario. Additionally, these remaining project costs are applied to the 15 percent local matching requirement.

Table 21. Details with using 20-Year 2004 Public Works Trust Funds at 0.5% Interest

Alternative	Surcharge rate %	Monthly Rate[1]	Monthly Surcharge	Total Monthly
Treatment Plant	118	$23.40	$27.61	$51.01
Conveyance Alt. 1	361	$23.40	$84.47	$107.87
Conveyance Alt. 2	330	$23.40	$77.22	$100.62
Conveyance Alt. 3	440	$23.40	$102.96	$126.36
Conveyance Alt. 4	439	$23.40	$102.73	$126.13
Conveyance Alt. 5	585	$23.40	$136.89	$160.29

(1): This is the adopted 2002 King County Sewer Rate

Public Works Trust Fund, 2004 and 2006.
In this scenario, PWTF loans of up to $10 million are secured in each of 2004 and 2006. The loans carry a 0.5 percent interest rate for a term of 20 years, with a 15 percent matching requirement on the recipient. All remaining project costs not covered by the PWTF loan are financed through King County Sewer revenue bonds at the terms specified for the bonding scenario. Additionally, these remaining project costs are applied to the 15 percent local matching requirement.

Table 22. Financing Details Associated with 2004 and 2006 Public Works Trust Funds

Alternative	Surcharge rate %	Monthly Rate[1]	Monthly Surcharge	Total Monthly
Treatment Plant	118	$23.40	$27.61	$51.01
Conveyance Alt. 1	326	$23.40	$76.28	$99.68
Conveyance Alt. 2	296	$23.40	$69.26	$92.66
Conveyance Alt. 3	398	$23.40	$93.13	$116.53
Conveyance Alt. 4	398	$23.40	$93.07	$126.47
Conveyance Alt. 5	543	$23.40	$127.06	$150.46

(1): This is the adopted 2002 King County Sewer Rate

CONCLUSIONS

To provide centralized treatment to the City of Carnation, the option of building localized treatment appears to be more feasible than extending a new regional conveyance interceptor from the City to the existing King County regional system.

Regional Conveyance

Depending upon the conveyance alternative selected, a new Carnation interceptor pipeline would vary in length from 11 to 18 miles and would require from two to four new pump stations to cross intermediate ridges. The project budgetary estimated construction costs for these conveyance alternatives would vary between $13.9 and $21.4 million. Applying King County's project budgeting model results in a range of conveyance project costs from $25.4 to $42.6 million.

Local Treatment

The Carnation Plan stated that Phase A would be operational by 2003 and that Phase B would be needed to be in operation by 2008. It is more likely that if the project permitting process would not be completed for approximately two years after the commitment is made to build the plant. With concurrent design and allowing for the bid process, construction could probably not start until some time in 2005. With an accelerated construction schedule, construction could probably be completed in late 2006. Given that Phase B would be needed in 2008, construction would have to then immediately start on Phase B. Given these assumptions, it would be advisable to build the initial Phase A and B concurrently.

It is apparent from the analysis that the capital cost of local treatment would be somewhat less than building conveyance. The Carnation Plan estimated the cost of a combined Phase A and B plant with phosphorus removal at $3.4 million. Evaluation of the design for this report resulted in a budgetary construction cost of $6.0 million. Using the King County budget model, results in a total budgetary project cost of $10.6 million. Addition of biological phosphorus removal and water reuse facilities would increase the costs slightly. The project cost would be phased over a period from 2001 to about 2007.

The annual operation and maintenance costs (year 2000) would vary between $345,000 and $421,000. At a three percent net discount rate over 20 years, an annual operating cost of $421,000 has a present value of approximately $6.3 million. Adding this cost to the capital cost results in a total present value for of the treatment of $16.9 million, which is still significantly less than the capital cost of conveyance options.

According to King County, depending upon financing alternative, the monthly surcharge would vary from $27.61 to $36.97 for local treatment and from $69.26 to $148.36 for one of five regional conveyance alternatives. These surcharges would be in addition to the new monthly rate of $23.40.

REFERENCES

Adolfson Associates, Inc. 2000. Habitat map of City of Redmond; prepared by L. Krippner.

American Engineering Corporation. November 2000. *City of Carnation Comprehensive Sewer and Facilities Plan*

King County. 1987. *King County Basin Reconnaissance Program Summary*. Prepared by King County Surface Water Management Division.

King County. 1990. *King County Sensitive Areas Map Folio*. Prepared by the Department of Parks, Planning and Resources, and Planning and Community Development Division.

King County and City of Issaquah. 1994. *Issaquah Creek Watershed Management Committee Proposed Basin and Nonpoint Action Plan*. Prepared by King County Department of Public Works and the Issaquah/East Lake Sammamish Watershed Management Committee.

King County Department of Natural Resources/ Water and Land Resources Division. 1998. Surface Water Design Manual. Document No. PUT 8-3-2 (PR). Seattle, Washington.

May, C. W., R. R. Horner, J. R. Karr, B. W. Mar, and E. B. Welch. 1997. Effects of Urbanization on Small Streams in the Puget Sound Lowland Ecoregion. Watershed Protection Techniques Vol. 2, No. 4.

National Marine Fisheries Service. 1996. Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale. NMFS Environmental and Technical Services Division.

U. S. Fish and Wildlife Service (USFWS). 1998. A Framework to Assist in the Making of Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Bull Trout Subpopulations Watershed Scale (Draft).

Washington Department of Fish and Wildlife. 1994. Salmon and Steelhead Stock Inventory. North Puget Sound Volume. Olympia, Washington.

Washington Department of Fish and Wildlife. 2000. Salmonid Stock Inventory Coastal Cutthroat Trout Volume. Accessed at http://www.wa.gov/wdfw/fish/sassi/cutthroat.htm on April 27, 2001.

Wesner, G.M. 2000. W/W Costs, version 3.0.

Williams, R.W., Laramie, R.M., and Ames, J.J. 1975. *A Catalog of Washington Streams and Salmon Utilization. Volume 1, Puget Sound Region*. Washington Department of Fisheries.

APPENDIX A
Technical Review of City of Carnation Wastewater Treatment Plant Engineering Report

TECHNICAL MEMORANDUM

King County

City of Carnation – Review of Wastewater Treatment Plant Engineering Report.

April 2, 2001

Introduction

King County is in the process of evaluating the feasibility of providing wastewater treatment to the City of Carnation, Washington. A draft Engineering Report dated May 31, 2000 was presented to HDR for review and comment.

Review of Engineering Report Pursuant to WAC 173-240-060

The following key elements pursuant to WDOE requirements are missing:

- Background data on:
  - Flood plain – Appears prospective plant site is in the 100 year flood plain as designated by King County.
  - Corps of Engineers will potentially have jurisdiction for any construction in the flood plain and in the river. This will require an extensive permitting, study, and alternative analysis process.
  - National Marine Fisheries will most likely be involved in the permitting process as well as the Washington State Department of Fish and Wildlife if there is construction in the flood plain, river or shoreline jurisdiction.
  - Endangered species/habitats – Appears Snoqualmie River is a habitat and spawning area for salmon. This will affect any discharge to the river and construction in the river.
  - Reliability class of facility.
- Basic design data for all processes such:
  - Surface loading rates
  - Depth
  - Detention times
  - Air requirements
  - RAS/WAS flow rates and pump horsepowers.
  - Equipment horsepower.
  - Selection of beta and alpha values dependent on diffuser type and selection.
  - Discussion of nutrient removal processes and their applicability to project and ability to be expanded or retrofitted into facility design.
  - Selection of disinfection systems, UV low-pressure, UV high-pressure, gaseous chlorination, sodium hypochlorite, sodium bisulfite, sulfur dioxide, ozonation
  - Filter media types and depths
  - Filtration rates, gpm/sqft

- Evaluation of alternatives
    - Costs
    - Environmental impact
    - Public acceptance
    - Solids management
- Final recommended alternative
    - Discussion of environmental impacts
    - Design life
    - Feasibility of implementation

Areas That Were Not Addressed

- Collection to a central pumping station and pumping/gravity flow to Bear Creek Interceptor for treatment in the King County System.
- Method of accessing capital and O&M costs for the facility to the end users should be developed.
- Labor, O&M costs for Biosolids management and water reuse is not addressed.

Items That Should Be Developed in Greater Detail

- Explanation of why extended aeration is only process that can meet ammonia, BOD and TSS limits while allowing for expansion to meet phosphorous limits. This is an inaccurate statement.
- Evaluation of SBR is limited and some statements are inaccurate.
- Grit removal and fine screen discussion does not address the grit issue in sufficient detail to suggest that the fine screen can remove grit and the grit that remains in the wastewater will not damage downstream process equipment.
- Disinfection discussion only addresses UV and no other alternatives. The discussion does not state the type of UV being evaluated.
- Filtration discussion does not address media particle size for removing the BOD nor the type or deep of media. Using an effluent manhole as the source of backwash water for a rapid sand filter usually is not adequate as the backwash rate is normally 4 times the filtering rate. Backwash, filtering, backwash waste rate and treatment of these flow streams needs additional explanation and development.
- Comparison of alternatives does not include costs, only a brief narrative.
- Discussion on biosolids alternatives is inaccurate when addressing the release of phosphorous on the treatment facility. Design of facility must account for phosphorous not removed in the biosolids
- Expand discussion on solids production and justification of quantities.
- Discussion on process impacts when the redundant secondary clarifier must be used as a secondary clarifier and not as a thickener.
- Reason for recommending four final clarifiers when requirements are to maintain 75% capacity with one out of service.
- Schrieber traveling bridge single media filter should be reviewed for acceptability as a reuse filter.

- Explain why only two 4 x 4 filters are required in Phase A and two in Phase B & C. Loading rates appear to be extremely high.
- Units and building are not sized; as a result, construction costs cannot be validated.
- Basis of costs for:
    - Electrical usage
    - Maintenance and equipment replacement
    - Fuel, tools and rental services
    - Insurance and administrative costs.
- Staffing for both operation and maintenance with one operator for holidays, weekends, vacations seems very low. Pervious discussion indicated that an on-call operator would respond to the plant alarm system when the plant was unmanned. This indicates that more than one operator would be assigned to the facility. Salary with fringe benefits for two people at $48,000 in the northwest appears to be low.

APPENDIX B
Carnation Treatment Plant
Biological Phosphorus Removal Process

CARNATION PROCESS

Calculations for the Carnation process focused on the Phase C build out condition. The each of the phases are essentially 1/3rd of the ultimate. All the results in this write-up can be divided by 3 to get a 1/3rd distribution.

Nitrification Design Only

Base Calculation

The base design is for nitrification of the flow. The results are shown in Table 1. The total volume for the basins is 0.65 MG to maintain the MLSS below 4,000 mg/L at max month condition and sludge age at 20 days.

Table 1. Base Design for Nitrification.

Parameter	Units	Average	MaxMonth
Flow	mgd	0.50	0.65
BOD	mg/L	282	282
TSS	mg/L	282	282
Basin Volume	MG	0.65	0.65
SRT	d	20.0	20.0
MLSS	mg/L	2,997	3,893
Yield	lb TSS/lb BOD	0.691	0.690
WAS	lbTSS/d	812	1,055
Effluent nitrate	mg/L	18.80	18.44
Oxidizable nitrogen	mg/L	19.12	19.13
Aeration required	lb/d	1,744	2,263

Lower Sludge Age Calculation

The minimum sludge age to sustain nitrification is on the order of 6 days. Therefore a design sludge age is typically about 12 days. Selecting 15 days, will reduce the overall basin volume as shown in Table 2. The total volume for the basins is 0.5 MG to maintain the MLSS below 4,000 mg/L at max month condition and sludge age at 15 days.

Table 2. Base Design for Nitrification.

Parameter	Units	Average	MaxMonth
Flow	mgd	0.50	0.65
BOD	mg/L	282	282
TSS	mg/L	282	282
Basin Volume	MG	0.50	0.50
SRT	d	15.0	15.0
MLSS	mg/L	3,022	3,924
Yield	lb TSS/lb BOD	0.714	0.714
WAS	lbTSS/d	840	1,091
Effluent nitrate	mg/L	18.14	18.39
Oxidizable nitrogen	mg/L	18.51	18.53
Aeration required	lb/d	1,693	2,196

Biological Phosphorus Removal

The design above was tested for biological phosphorus removal (BPR) with some assumptions. Based on the results, it appears the process for BPR is feasible. Suggest a UCT style design with two anaerobic zones, with the return activated sludge (RAS) fed to second zone and internal recycling from zone 2 to 1. This will protect the anaerobic zone from nitrate recycling through the system when no denitrification is practiced. This design requires:

- Anaerobic Zone 1 – 0.02 MG, receiving influent and recycle from Zone 2.
- Anaerobic Zone 2 – 0.02 MG, receiving RAS and flow from Zone 1.
- Aerobic Zone – from previous aerobic basin at 0.5 MG.

Note, these are total volumes for Phase C built out conditions. Divide the volumes in three for each of the three phases.

Under this mode the aeration requirements are slightly reduced by about 100 lb. per day.

APPENDIX C
W/W Cost Model Outputs

HDR Engineering
WATER/WASTEWATER TREATMENT PROCESSES - COST SUMMARY

TITLE: Carnation Treatment Plant - Phase A DESIGN FLOW, MGD: **0.220** ACTUAL FLOW, MGD: **0.170**

Process	No.	Design Parameter		Operating Parameter		Constr, $	Cents/1000 Gallons O&M	Debt	Total
1 Primary Treatment Screens	101	0.6	mgd	0.2	mgd	101013	11.87	32.99	44.87
2 Backup Treatment Screens	101	0.6	mgd	0.0	mgd	101013	0.04	32.99	33.03
3 Vortex Grit Removal Chamber	100	0.2	1,000 cu ft	0.2	mgd	91698	27.59	29.95	57.54
4 Anaerobic Basins	16	1.0	1,000 cu ft	1.0	1,000 cu ft	39165	5.96	12.79	18.75
5 Anoxic Basins	16	1.0	1,000 cu ft	1.0	1,000 cu ft	39165	5.96	12.79	18.75
6 Recycle Pumping Station TDH = 40 feet	103	0.1	mgd	0.1	mgd	13728	36.07	4.48	40.55
7 Aeration Basins - Rectangular	20	11.5	1,000 cu ft	0.0		212408	0.00	69.38	69.38
8 Air Diffusion System	27	0.2	1,000 cfm	0.1	1,000 cfm	14647	11.84	4.78	16.62
9 Aeration Basins - Rectangular	20	11.5	1,000 cu ft	0.0		212408	0.00	69.38	69.38
10 Air Diffusion System	27	0.2	1,000 cfm	0.1	1,000 cfm	14647	11.84	4.78	16.62
11 Air Supply Systems	26	0.3	1,000 cfm	0.2	1,000 cfm	136927	35.53	44.72	80.25
12 Circular Sedimentation Basin Number of units = 1	116	706.9	sq ft	706.9	sq ft	174120	10.56	56.87	67.43
13 Circular Sedimentation Basin Number of units = 1	116	706.9	sq ft	0.0	sq ft	174120	0.00	56.87	56.87
14 Sludge Pumping Station	106	91.7	gpm	70.8	gpm - Average	217917	11.90	71.18	83.07
15 Gravity Filtration Structure	56	69.0	sq ft	69.0	sq ft	232196	45.66	75.84	121.50
16 Filter Media - Sand	57	69.0	sq ft	0.0		2757	0.00	0.90	0.90
17 Backwash Pumping Station	60	414.0	gpm	414.0	sq ft	58858	16.30	19.22	35.53
18 Ultraviolet Light Disinfection	147	0.3	mgd	0.2	mgd	218776	27.89	71.46	99.34
19 Outfall - Prestressed Concrete Length = 1320 feet	184	18.0	inches diam	0.0		92202	0.00	30.11	30.11
20 Sludge Holding Tank Mixing hp = 5.0 /1000 CuFt	134	6.7	1,000 cu ft	6.7	1,000 cu ft	140984	68.41	46.05	114.46
21 Lab, Maintenance, Adm Building	81	0.6	mgd	0.2	mgd	113784	36.58	37.16	73.74
					Total Costs, $	2402533	363.99	784.71	1148.70

Sitework, Interface Piping,	18.0%	432500
Standby Power,	25.0%	600600
Gen Contractor OH & P,	10.0%	343600
Engineering,	25.0%	944800
Legal,Fiscal,Admin		41800
Int During Constr		293800

Present Worth of O&M @ 7.25% and 20 yrs $ 2346900 + Total Capital, $ 5059633 = Present Worth $ 7406533

TITLE: Carnation Treatment Plant - Phase A DESIGN FLOW, MGD: **0.220** ACTUAL FLOW, MGD: **0.170**

O&M	KWH	Materials, $	Labor, Hr	Diesel, Gal	Nat Gas, Cu Ft	Chemicals, $	TOTAL, $/Yr
**** TOTAL ****	366165	27268	4551	12	12	0	225854
Process 1	354	160	189	1	1	0	7368
Process 2	353	0	0	0	0	0	25
Process 3	8440	3721	337	1	1	0	17119
Process 4	6355	98	83	1	1	0	3698
Process 5	6355	98	83	1	1	0	3698
Process 6	12954	191	560	1	1	0	22379
Process 7	1	0	0	0	0	0	0
Process 8	2	1719	148	1	1	0	7344
Process 9	1	0	0	0	0	0	0
Process 10	2	1719	148	1	1	0	7344
Process 11	31852	2068	467	1	1	0	22045
Process 12	4901	509	150	1	1	0	6553
Process 13	1	0	0	0	0	0	0
Process 14	1022	3702	95	0	0	0	7384
Process 15	306	985	719	1	1	0	28330
Process 16	1	0	0	0	0	0	0
Process 17	9888	1824	200	0	0	0	10116
Process 18	47468	3910	265	1	1	0	17304
Process 19	1	0	0	0	0	0	0
Process 20	234588	2202	627	0	0	0	42449
Process 21	1320	4362	480	1	1	0	22696

Date of Current Indicies - January 2000

Capital Cost Factors

Engineering (%)	= 25.0
Sitework, Interface Piping (%)	= 18.0
Subsurface considerations (%)	= 0.0
Standby power (%)	= 25.0
Interest Rate (%)	= 7.3
Number of Years	= 20.0
Land cost, $/Acre	= 15000.0
ENR Building Cost Index	= 3503.32
ENR Skilled Labor Index	= 5641.26
ENR Materials Price Index	= 2197.44

Unit Cost Factors

Electricity, $/KWH	= 0.0700
Labor, $/Hr	= 38.0000
Diesel Fuel, $/Gal	= 1.3500
Natural Gas, $/Cu Ft	= 0.0060
Building Energy Use, KWH/Sq Ft/Yr	= 102.6000

HDR Engineering
WATER/WASTEWATER TREATMENT PROCESSES - COST SUMMARY
PAGE 1

TITLE: Carnation Treatment Plant - Phase A&B   DESIGN FLOW, MGD: **0.430**   ACTUAL FLOW, MGD: **0.330**

	Process	No.	Design Parameter		Operating Parameter		Constr, $	Cents/1000 Gallons O&M	Debt	Total
1	Primary Treatment Screens	101	0.6	mgd	0.3	mgd	101013	7.94	17.10	25.05
2	Primary Treatment Screens	101	0.6	mgd	0.0	mgd	101013	0.02	17.10	17.12
3	Vortex Grit Removal Chamber	100	0.2	1,000 cu ft	0.3	mgd	91698	19.63	15.53	35.16
4	Anaerobic Basins	16	1.0	1,000 cu ft	1.0	1,000 cu ft	39165	3.07	6.63	9.70
5	Anoxic Basins	16	1.0	1,000 cu ft	1.0	1,000 cu ft	39165	3.07	6.63	9.70
6	Anaerobic Basins	16	1.0	1,000 cu ft	1.0	1,000 cu ft	39165	3.07	6.63	9.70
7	Anoxic Basins	16	1.0	1,000 cu ft	1.0	1,000 cu ft	39165	3.07	6.63	9.70
8	Recycle Pumping Station	103	0.2	mgd	0.2	mgd	28669	20.42	4.85	25.27
	TDH = 40 feet									
9	Aeration Basins - Rectangular	20	23.0	1,000 cu ft	0.0		336202	0.00	56.92	56.92
10	Air Diffusion System	27	0.3	1,000 cfm	0.2	1,000 cfm	27567	8.33	4.67	13.00
11	Aeration Basins - Rectangular	20	23.0	1,000 cu ft	0.0		336202	0.00	56.92	56.92
12	Air Diffusion System	27	0.3	1,000 cfm	0.2	1,000 cfm	27567	8.33	4.67	13.00
13	Air Supply Systems	26	0.6	1,000 cfm	0.4	1,000 cfm	167600	27.15	28.38	55.52
14	Circular Sedimentation Basin	116	706.9	sq ft	706.9	sq ft	348240	10.88	58.96	69.84
	Number of units = 2									
15	Sludge Pumping Station	106	179.2	gpm	137.5	gpm - Average	315956	8.71	53.50	62.21
16	Polymer Feed System	44	35.8	lb/day	27.5	lb/day	66251	26.60	11.22	37.82
	$ 2.25/lb , 10030.200 lb /yr for Polymer									
17	Gravity Filtration Structure	56	138.0	sq ft	138.0	sq ft	341056	29.64	57.75	87.38
18	Filter Media - Sand	57	138.0	sq ft	0.0		5031	0.00	0.85	0.85
19	Backwash Pumping Station	60	414.0	gpm	414.0	sq ft	58858	8.40	9.97	18.36
20	Ultraviolet Light Disinfection	147	0.6	mgd	0.3	mgd	357857	20.58	60.59	81.17
21	Outfall - Prestressed Concrete	184	18.0	inches diam	0.0		92202	0.00	15.61	15.61
	Length = 1320 feet									
22	Sludge Holding Tank	134	6.7	1,000 cu ft	6.7	1,000 cu ft	140984	35.24	23.87	59.11
	Mixing hp = 5.0 /1000 CuFt									
23	Belt Filter Press	125	7.5	gpm	5.8	gpm	743257	32.45	125.84	158.29
	$ 2.25/lb , 50.340 lb /yr for Polymer									
24	Lab, Maintenance, Adm Building	81	0.6	mgd	0.3	mgd	113784	27.62	19.27	46.88
						Total Costs, $	3957667	304.23	670.09	974.33

Sitework, Interface Piping,	18.0%	712400
Standby Power,	25.0%	989400
Gen Contractor OH & P,	10.0%	565900
Engineering,	25.0%	1556300
Legal,Fiscal,Admin		58500
Int During Constr		546900

Present Worth of O&M @ 7.25% and 20 yrs $ 3807900 + Total Capital, $ 8387067 = Present Worth $ 12194967

HDR Engineering
WATER/WASTEWATER TREATMENT PROCESSES - COST SUMMARY

TITLE: Carnation Treatment Plant - Phase A&B   DESIGN FLOW, MGD: **0.430**   ACTUAL FLOW, MGD: **0.330**

O&M	KWH	Materials, $	Labor, Hr	Diesel, Gal	Nat Gas, Cu Ft	Chemicals, $	TOTAL, $/Yr
**** TOTAL ****	549258	39906	6984	16	16	22681	366449
Process 1	354	270	244	1	1	0	9568
Process 2	353	0	0	0	0	0	25
Process 3	11217	4695	478	1	1	0	23646
Process 4	6355	98	83	1	1	0	3698
Process 5	6355	98	83	1	1	0	3698
Process 6	6355	98	83	1	1	0	3698
Process 7	6355	98	83	1	1	0	3698
Process 8	18944	277	605	1	1	0	24594
Process 9	0	0	0	0	0	0	0
Process 10	2	2094	209	1	1	0	10037
Process 11	0	0	0	0	0	0	0
Process 12	2	2094	209	1	1	0	10037
Process 13	64430	3030	662	1	1	0	32697
Process 14	9801	1018	300	2	2	0	13107
Process 15	1906	5612	125	0	0	0	10495
Process 16	17401	582	202	0	0	22568	32044
Process 17	520	1612	896	1	1	0	35698
Process 18	1	0	0	0	0	0	0
Process 19	9888	1824	200	0	0	0	10116
Process 20	92116	7169	294	1	1	0	24790
Process 21	1	0	0	0	0	0	0
Process 22	234588	2202	627	0	0	0	42449
Process 23	60994	1525	873	1	1	113	39083
Process 24	1320	5510	728	1	1	0	33268

Date of Current Indicies - January 2000

Capital Cost Factors		Unit Cost Factors	
Engineering (%)	= 25.0	Electricity, $/KWH	= 0.0700
Sitework, Interface Piping (%)	= 18.0	Labor, $/Hr	= 38.0000
Subsurface considerations (%)	= 0.0	Diesel Fuel, $/Gal	= 1.3500
Standby power (%)	= 25.0	Natural Gas, $/Cu Ft	= 0.0060
Interest Rate (%)	= 7.3	Building Energy Use, KWH/Sq Ft/Yr	= 102.6000
Number of Years	= 20.0		
Land cost, $/Acre	= 15000.0		

ENR Building Cost Index = 3503.32
ENR Skilled Labor Index = 5641.26
ENR Materials Price Index = 2197.44